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The Impact of Daycare and Child Temperament on Parent-Child Interactions

Kyle Bersted
Southern Illinois University Carbondale, kbersted@yahoo.com

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by

Kyle A. Bersted

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Kyle A. Bersted, B.A.

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Dr. Lisabeth DiLalla, Chair

Dr. David DiLalla

Dr. Stephanie Dollinger

Graduate School
Southern Illinois University Carbondale
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This study explored the potential impact of child temperament and daycare on behavior problems and parental sensitivity. It was expected that children with more "difficult" temperaments would exhibit more behavior problems and have less sensitive parents when experiencing high amounts of daycare. Measures from 60 families involved in the Southern Illinois Twins and Siblings Study (SITSS) were examined. Results indicated that highly active children exhibited more externalizing behaviors when experiencing less daycare. Shy children experiencing more daycare had more sensitive parents. Additionally, a temperamental difference between co-twins was related to differential parental sensitivity. Lastly, DZ co-twins were more temperamentally different when experiencing high amounts of daycare. These results demonstrate that daycare does seem to affect children; however, the specific effect depends on the child's temperament. Additionally, temperament is an important factor when examining parental sensitivity shown to twins and when determining how MZ and DZ twins react to daycare.

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CHAPTER 1

INTRODUCTION

Daycare has been a popular research topic for a number of years, as psychologists have wondered what effects, if any, daycare experience has on a child's development. As the percentage of children attending center-based daycare remains large (Laughlin, 2010), this issue holds relevance for parents, researchers, and educators. Daycare quantity and quality have been examined in relation to a number of different cognitive and socioemotional variables, including children's academic performance, internalizing and externalizing behaviors, and relations with peers and parents (Shpancer, 2006). Generally, it seems that daycare quality has a larger effect on a child's cognitive and language functioning, whereas daycare quantity has a more pronounced effect on children's socioemotional functioning (Belsky, 2002). However, the effects of daycare on any area of a child's functioning rely on a number of factors, thus making it a complicated variable to understand fully (Shpancer, 2006).

Another widely studied topic in the literature is child temperament. Although differences in definitions exist, temperament can best be described as individual differences in behavioral tendencies that are biologically rooted and relatively stable over time, yet also can be modified to a moderate degree due to environmental and maturation factors (Goldsmith et al., 1987). Among other factors, activity level and emotionality are the two primary dimensions that are measured in order to assess child temperament (Crockenberg, 2003). Other dimensions include, but are not limited to, adaptability, sensory threshold, mood, distractibility, and sociability (Buss & Plomin, 1984; Rothbart, Ahadi, & Hershey, 1994; Thomas & Chess, 1977).

Temperament has been studied in a variety of ways, both as a potential cause of various outcomes as well as an effect of certain circumstances. For example, temperament has been linked with various externalizing and internalizing disorders later in life (Zentner & Bates, 2008) and has been shown to predict social behaviors with peers (Root & Stifter, 2010). On the other hand, temperament also has been found to be negatively affected by prenatal stress (Huizink, 2008). Further, investigations into gene x environment interactions have suggested that individuals with certain temperamental characteristics are more and less likely to exhibit certain behaviors based on their environments. This interaction between temperament and environment is referred to as the differential susceptibility hypothesis (Pluess & Belsky, 2011), although this research is still in its early stages. Nevertheless, it is clear that child temperament plays a big role in many areas of a child's development.

One aspect of a child's life that can be affected by both daycare experience and child temperament is parent-child interactions. Child temperament has been shown to be more related to the behavior of a parent than to the child's behavior during an interaction (Webster-Stratton & Eyberg, 1982), illustrating the effect that temperament can potentially have on an interaction. It is also worth noting that a circular or transactional effect exists within these interactions, as parent behavior can have an effect on child behavior as well (Sameroff, 2009). Nevertheless, it is clear that temperament plays a role in predicting the outcome of parent-child interactions. Additionally, daycare experience has been shown to affect parent-child interactions. More specifically, it has been found that time spent in daycare has detrimental effects on parent-child interactions, as parents who place their children in daycare for longer periods of time throughout the week tend to be less sensitive and prompt in their responses to their child's signs of distress (Ahnert, Rickert, & Lamb, 2000; NICHD, 1999).

Extensive research has been conducted on temperament, the effects of daycare, and parent-child interactions as their own separate constructs; however, little research exists examining the effects of all three in combination. Although some studies manage to include two of these constructs, very few studies attempt to examine all three when investigating the effects of daycare on young children. For example, a number of studies have shown that time spent in daycare has more adverse effects on children with difficult temperaments when compared to those with more positive temperaments, mainly resulting in more distress for these children in the daycare setting (Crockenberg & Leerkes, 2005; Watamura, 2003). The term "difficult temperament" refers to a number of different child characteristics and varies from study to study. Negative affect, irritability, aggression, anger, shyness, impulsivity, and high reactivity have all been used to characterize a difficult temperament (e.g. Crockenberg & Leerkes, 2005; Dettling, Gunnar, & Donzella, 1999) but seem to represent children with a tendency to exhibit either externalizing or internalizing behaviors. More generally, all children do not react to the daycare setting in the same way (Crockenberg, 2003). Thus, instead of focusing on the general conditions of daycare that may negatively or positively affect a child, the focus should be on a child's individual differences and how they specifically relate to the conditions of daycare that each child experiences (Phillips, Fox, & Gunnar, 2011). These studies hold importance for further understanding of the effects of daycare on children; however, this research should not stop here. How does differential reactivity to daycare affect children at home? How does it affect their interactions with their parents? Researchers, as well as parents, should be interested in these questions given the popularity of daycare today.

Luckily, the examination of parent-child interactions is not completely lost in the daycare literature, as alluded to earlier. Another group of studies focuses on the effects of time spent in

daycare on the interactions between parent and child, finding that parents tend to respond less sensitively to children who spend long hours in daycare (NICHD, 1999). However, much like the previous group of studies, this research also leaves out an important construct. Although these findings are important for understanding the potential effects that time spent in daycare can have on children and parents during their interactions with one another, they don't tell the entire story. Without knowledge of specific child characteristics (e.g., temperament), these findings cannot be fully understood. Do all parents respond less sensitively to their children who spend time in daycare? Or does this only apply to children with difficult temperaments, who according to other literature, are negatively affected by time spent in daycare? Temperament can play a big role in determining a child's reaction to the daycare setting and without knowledge of it, studies investigating daycare's effects on parent-child interactions may be missing a crucial piece to the puzzle. As Shpancer (2006) notes, the actual effects of daycare on development are not simple; rather, they rely on complex interactions between variables. Upon review of the literature, temperament appears to be one of these variables. Therefore, due to the interconnectedness of these three constructs, temperament should be examined when investigating the potential implications of daycare on interactions between children and their parents.

The current study utilizes the twin method, allowing for the examination of both genetic and environmental influences on behavior. By knowing the differences between monozygotic twins (MZ; share 100% of their genetic material) and dizygotic twins (DZ; share on average 50% of their genetic material), the effects of both factors can be estimated, as well as the potential relationship between them (gene-environment correlation). Although specific genes were not examined in this study, several studies have shown that certain genes do play an important role

in interaction behaviors (Copeland, et al., 2011; DiLalla, Elam, & Smolen, 2009; Moles, Kieffer, D'Amato, 2004), thus validating the use of behavioral genetics.

This study attempted to fill the gap in the literature by examining parent-child interactions with an added emphasis on time spent in daycare and child temperament. In other words, the major focus of the current study is on how child temperament and time spent in daycare may potentially interact to affect parent-child interactions. However, before parent-child interactions were examined, the potential interactive relationship between daycare and child temperament was explored by examining its relationship with parent-rated behavior problems. This fulfills the need for further daycare researcher that is carried out with individual differences in mind, as highlighted by Phillips et al. (2011). Additionally, the use of the twin method allowed for the examination of genes and environment to be added in the analyses of the constructs used in this study. More specifically, differences between MZ and DZ twins were investigated in order to examine the potential effects of shared genes, shared environment, and nonshared environment on twins' reactions to daycare and their parent's reactions to them in during an interaction.

CHAPTER 2

LITERATURE REVIEW

In 2007, 55 percent of children ages 3-6 were enrolled in some type of center-based daycare (Laughlin, 2010). With parents continuing to rely on daycare for their children, consequent studies of daycare have been plentiful. Moreover, the resulting range of potential effects of daycare is quite large. A number of benefits as well as consequences have been discovered when examining the effects of daycare on a variety of aspects of a child's life (Beslky et al., 2007). One particular aspect that has been of interest to researchers is the potential effect of daycare on parent-child interactions. It has been suggested that long hours spent in daycare relate to less parental sensitivity and less positive child engagement during interactions (NICHD, 1999). However, not all children react similarly to experiencing daycare (Crockenberg, 2003). Research has shown that temperament is of importance, as children with difficult temperaments react more negatively to time spent in daycare than those with positive temperaments (Dettling, Parker, Lane, Sebanc, & Gunnar, 2000). "Difficult temperament" is a broad term used frequently in the literature that can refer to a number of child characteristics, such as negative affect, irritability, aggression, anger, shyness, impulsivity, and high activity/reactivity (Crockenberg & Leerkes, 2005; Dettling et al., 1999). Therefore, if a child's temperament can help determine how he or she reacts to daycare, this unique reaction could potentially affect how the child then interacts with his or her parent and vice versa. As a result, it seems that temperament must be taken into account in order to properly examine the potential effects of time spent in daycare on parent-child interactions. However, there seems to be a gap in the literature in this regard. While extensive research has been conducted on temperament, the

effects of daycare, parent-child interactions, and a mixing of at least two of these constructs, little research exists examining the effects of all three in combination.

The current study attempts to address this gap by examining how daycare experience and temperament potentially interact to affect parent-child interactions. The literature review begins with separate sections briefly explaining what we know about daycare and temperament as separate constructs. Then, the literature that examines temperament as it relates to the effects of daycare is analyzed. Similarly, the literature that investigates the effects of daycare on parent-child interactions as well as the effects of temperament on parent-child interactions also is explored. A section on behavioral genetics also is included, as studying the effects of a child's genetics can be useful when investigating how the child is affected by his or her surrounding environment. This study uses a twin sample, which allows comparisons among twin pairs, leading to an even deeper exploration of the potential interactions between a child's genes and environment. To conclude the literature review, a summary of the current study and a set of specific hypotheses are offered.

Daycare

Studies on daycare and its range of potential effects on children and parents are abundant, although results of these studies are not always consistent with one another (Shpancer, 2006). Among other variables, children's cognitive functioning, language functioning, social functioning, externalizing behavior, internalizing behavior, and interactions with parents have all been examined in relation to time spent in daycare. However, before analyzing results of such studies, the term daycare needs to be defined. Nonparental childcare is often the term used in relevant literature; yet this term can include a variety of daycare environments, such as relative or nanny care, small family-based daycares, and center-based daycare centers (Shpancer, 2002).

Distinctions among these daycare types are important because although sometimes described in the same way, these placements have differences, such as in quality of care, the physical environment, and the caregiver relationships with the children. For the purposes of this study, daycare experience refers to three kinds of care that occur outside of the home: prekindergarten, informal church daycare, and licensed center-based daycare.

Quantity and Quality

Another relevant topic in the daycare literature relates to particular features of the daycare experience, more specifically, whether quantity or quality of daycare will be the focus of the investigation. In terms of cognitive development, language development, and academic achievement, it seems that quality of daycare matters most (Belsky, 2009). For example, The National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development followed children from across the United States from birth to age three to evaluate the potential effects of daycare on various areas of child development. One follow-up study (NICHD, 2000) examined the effects of daycare quality on cognitive and language development. Findings indicated that quality of daycare; defined as care that was attentive, appropriately responsive, positively affectionate, not excessively restrictive or intrusive, and which offered activities believed to promote cognitive and social development, was a consistent predictor of cognitive and language outcomes at ages 15, 24, and 34 months. These outcomes included specific measures that assessed things such as memory, learning, problem solving, early verbal communication, and vocabulary comprehension and production. Specifically, language stimulation provided by daycare workers, which was one aspect of determining daycare quality, was an important predictor of increased functioning in these areas. Additionally, it was found that quantity of daycare, defined by average number of hours per week of nonmaternal childcare

up to that point, had no effect on any cognitive or language measures. Therefore, it seems that quality, not quantity, of daycare has the biggest influence on children's cognitive and language functioning.

On the other hand, other studies have found quantity of daycare to have an effect on child development. However, daycare quantity can potentially be a difficult construct to operationalize, meaning that studies tend to differ in how each defines "long" or "large amounts" of daycare. Nevertheless, upon review it seems that the majority of studies finding effects of daycare quantity assess average number of hours per week (Jacob, 2009). DiLalla (1998) found that amount of daycare experienced was a significant predictor of prosocial behaviors exhibited by preschoolers during a peer interaction, although total months of daycare, not average hours per week, was used to assess daycare quantity. Specifically, children who had been exposed to less daycare behaved in a more prosocial manner with peers, suggesting that daycare experience may hinder social development. Despite spending more time with peers in daycare, more time spent in daycare seemed to inhibit social functioning. Perhaps less time spent with parents is a more significant contributor to daycare's effects than more time spent with peers in the daycare setting. Regardless of the cause of this behavior, it is important to examine parent-child interactions, which this study does. Other studies have found daycare quantity to affect socioemotional functioning as well. In a paper evaluating relevant studies published between 1998 and 2006, Jacob (2009) found that quantity (hours per week) of non-maternal childcare was the most consistent and significant predictor of negative social-behavioral adjustment across all ages, even when quality of care was also examined. These findings suggest that when examining social and emotional functioning, quantity of daycare may matter most.

Therefore, quality and quantity are both important factors to consider when examining daycare's effects on development; however, it seems that they affect different areas of functioning. Belsky (2002) further explained this distinction: though there are effects of high-quality and low-quality daycare (mainly on cognitive, academic, and language functioning), they are largely independent of the effects that quantity of daycare can have, mainly on the child's social and emotional functioning. A child's social and emotional behavior, observable in most situations, should be visible during a parent-child interaction, which is the main focus of the current study. Therefore, since it seems that socioemotional behaviors are most affected by daycare quantity, examining daycare quantity, rather than quality, is justified.

Attachment

Based on this review, the quality versus quantity debate seems to have reached some general conclusions in relation to daycare's effects, with quality mattering more for cognitive outcomes and quantity mattering more for socioemotional outcomes. However, the debate would not be complete without mention of Mary Ainsworth and attachment theory, as daycare's potential effects on attachment between child and parent also have been a central theme of the daycare literature (Shpancer, 2002). Ainsworth first began work in 1963 by observing infants and their mothers in Uganda, then expanded the theory through her classic strange situation study (Ainsworth, 1970). This eventually led to the classification system of attachment styles, which explains that infants are either securely or insecurely attached to their mothers, with the latter including both anxious-resistant and anxious-avoidant types (Ainsworth, 1978). A fourth type, disorganized, has since been added (Main & Solmon, 1986). Each type of attachment describes children's behavior both with and without their mother during a separation and is said to reflect the quality of the infant-mother relationship. Ainsworth explained that the quality of

the relationship mattered most when it came to attachment between infant and mother (Bretherton, 1992). Generally speaking, securely attached infants seek comfort from their mothers yet are able to explore the environment on their own, using their mothers as a secure base for exploration. On the other hand, insecurely attached infants are either unable to separate from their mothers and resent them for leaving or do not seem to have much of a connection to their mothers at all, either before or after separation.

Attachment theory is a widely studied paradigm and thus has been examined in various ways, including in relation to daycare experience. Numerous studies have shown that securely attached children are able to function more positively with peers and are more socially competent in the daycare setting, whereas insecurely attached children may be at risk for social problems (Shpancer, 2002). However, the more pertinent topic in the literature has been how daycare may affect a child's attachment to his or her parents. Belsky (1986) originally suggested that children who spend more than 20 hours per week in daycare are at risk for developing insecure attachments; however, this claim has since been refuted.

A meta-analysis performed by Phillips and colleagues (1987) found that there were no significant differences in attachment between home-reared children and children who spent time in daycare. More recently, an NICHD (1997) study found that daycare experience has no effect on attachment security. As mentioned, Belsky (2009) has since changed his stance on the issue, agreeing with the notion that attachment security seems to be unaffected by daycare experience. As it relates to the current study and its interest in the effects of daycare, it therefore seems that child attachment should not be affected by daycare experience. Although attachment styles that the child has already developed with the parent may very well manifest during interactions, daycare experience should not have a large effect on them. Attachment is most reliant on

relationship history as well as the present dynamics of the relationship (Shpancer, 2002), with other factors having little influence on it.

Duration of Effects

Yet another topic of discussion when discussing daycare research is whether or not the effects of daycare are short-term or enduring throughout childhood. Much like other areas of daycare literature, findings are mixed. Some have found that effects of daycare, both beneficial and detrimental, do not endure beyond preschool, whereas others have found the opposite, with effects enduring into the elementary school years and beyond (Belsky et al., 2007). However, it does seem that certain groups of effects differ in endurance, much like certain groups of effects differ based on daycare quality and quantity. According to a follow-up NICHD (2005) study that followed children through third grade, higher quality care was still predictive of better academic performance, as it was at age four-and-a-half in the initial NICHD study. Findings also indicated that daycare quantity no longer predicted externalizing problems but instead was associated with conflicted relationships with teachers and mothers.

Belsky (2007) continued this investigation by examining children from the NICHD study at 12 years old in order to determine whether or not initial associations between daycare and child functioning were still evident. Again, higher quality care was associated with higher vocabulary scores but higher daycare quantity was predictive of more externalizing problems, unlike the NICHD (2005) study. These two effects were the only effects to remain statistically significant, suggesting that although other effects of daycare may dissipate, these effects may endure throughout childhood. Belsky & Pluess (2011) also found that daycare experience was predictive of externalizing behavior later in adolescence for children with difficult temperament.

However, instead of daycare quantity, it was daycare quality that was found to predict to later externalizing problems. Therefore, regardless of quantity or quality, it is important to examine these effects contemporaneously with daycare because of the fact that any initial cognitive or socioemotional effects of daycare may stay with a child longer term. Studying them from the onset can allow for earlier detection and thus more successful solutions to stopping the detrimental effects of both lower cognitive/academic functioning and more problem behaviors due to daycare factors. The current study investigates the parent-child interactions of four-year-olds but does not examine any future interactions, thus focusing only on these immediate effects of daycare.

Although all of these studies are important in examining daycare's potential effects on children's development and functioning, a key component must also be included in the investigation: child temperament. Even though daycare has been found to have numerous effects on different areas of a child's life, it is also known that not all children react similarly to the daycare environment (Crockenberg, 2003). Among other factors, temperament seems to play a big role in determining how a child experiences daycare and thus can help shed light on how daycare may affect various areas of their functioning.

Temperament

One of the most influential discussions of temperament came in 1987 when Goldsmith, Buss, Plomin, Rothbart, Thomas, and Chess each attempted to define temperament as a construct in a roundtable published in Child Development. Each theorist explained what temperament is, what its elements are, and how it is formed and maintained throughout childhood according to their own theories. Although disagreements were abundant, a few general points of consensus

were also evident. First, temperament has strong biological underpinnings and is therefore best to study in infancy in order to examine its direct effect on observed behavior. Additionally, although temperament is understood as a stable and continuous construct, the expression of temperament may be modifiable throughout life based on a child's environment. Third, temperament reflects individual differences and is a component of personality (although each theorist differs in how specific boundaries between personality and temperament should be conceptualized). Also, temperamental dimensions reflect behavioral tendencies rather than describe discrete behavioral acts. Among other dimensions, adaptability, sensory threshold, mood, attention span, distractibility, soothability, and levels of frustration and distress have all been included in various definitions of temperament (Buss & Plomin, 1984; Rothbart, Ahadi, & Hershey, 1994; Thomas & Chess, 1977). Despite these differences, the theorists did agree that activity level and emotionality both need to be considered as primary temperamental dimensions (Goldsmith et al., 1987). This notion still holds weight today as most experts agree that temperament should include both reactive and regulatory components (Crockenberg, 2003). Reactive components include arousability of motor, affective, and sensory response systems, whereas regulatory components include attentional focus, activity level, and inhibitory control, all of which serve to regulate reactivity (Rothbart, Ahadi, Hershey, & Fisher, 2001).

Shiner et al. (2012) revisited the classic review by Goldsmith et al. (1987) in order to review the advancements in the literature that have since shaped our current view of temperament. The authors highlighted new findings suggesting that not all temperament traits are stable early in life, with some emerging later in infancy and potentially affecting other traits when they appear. Additionally, the authors note that older definitions of temperament were not capturing all relevant dimensions of temperamental behavior, citing new research that points to

dimensions of self-regulation and attention that play an important role as well. The authors also discussed how the growing emphasis on the interconnectedness of biology and environment is important to consider when examining temperament. Taken together, the authors proposed that temperament traits should now be classified as "early emerging basic dispositions in the domains of activity, affectivity, attention, and self-regulation, and these dispositions are the product of complex interactions among genetic, biological, and environmental factors across time" (p. 2).

Measurement

As illustrated, there are numerous ways to conceptualize and describe temperament. Consequently, there are a number of methods to measure temperament, each with different categories, dimensions, and concepts describing the construct that parents must rate their child on. For example, Thomas and Chess (1977) provide questions about child behavior that map onto nine different temperamental categories, whereas the Child Behavior Questionnaire (CBQ; Rothbart et al., 2001) asks questions of parents whose answers map onto fifteen different temperamental dimensions. Despite differences among the specific behaviors being measured, each method represents an attempt to assess biologically rooted individual differences in emotionality and behavioral tendencies that are relatively stable, yet can be modified by individual maturation and environmental factors to some degree (Kivij□rvi et al., 2005).

Temperament can be measured in a number of ways, including via parent reports and observer ratings in a number of different environments (Rothbart & Hwang, 2002). The questionnaires noted above, as well as the measure used in the current study, are parent report. Saudino (2003a) notes that parents can provide valuable information regarding child temperament because they know their children well and see them behave in a number of

different settings. In support of parent reported temperament, Rothbart and Bates (1998) have found parent report measures to have fair degrees of objective validity, yet also note that parent report measures are still vulnerable to biases. For example, parent ratings of fraternal (dizygotic, DZ) twins are often very poorly correlated, implying that these twins are no more similar than two randomly-paired children, despite their 50% genetic overlap (Saudino, 2003b). This may be explained by parent biases that overestimate differences between DZ twins, known as contrast effects. At the same time, parents may also inaccurately inflate the similarity between two identical (monozygotic, MZ) twins, a bias known as an assimilation effect. A third explanation for potential differences between MZ and DZ twins is that DZ similarity may be less than one-half that of MZ twins if non-additive genetic variance contributes to a behavior. This refers to when genes are not linear or additive and thus an observed phenotype does not represent the sum of the average genetic effect (Saudino, 2003b). Although these effects can be due to a number of factors, parent anxiety in particular has been shown to correlate with the perception of difficult temperament (Vaughn et al, 1981). This not only suggests that parental characteristics can have an effect on temperament ratings, it also reflects the fact that parent-rated temperament may be genetically influenced (Saudino, 2003b).

Despite these flaws, parent report measures of temperament are still widely used, mostly due to their ease of use and low cost (Rothbart & Mauro, 1990). Although more objective measures of temperament show fewer contrast effects (Saudino, McGuire, Reiss, Hetherington, & Plomin, 1995), these observational methods are costly and may not be as accurate. More importantly, these measures cannot always be adequately compared to parent reports of temperament (Carey, 1983). Observational measures only take into account behavior over a short period of time in one context, whereas parent report accounts for all behavior in a variety of

contexts throughout the child's life. Fortunately, there seems to be a fair level of overlap between parent report and observational measures of temperament (Bridges, Palmer, Morales, & Hurtado, 1993), indicating that despite the potential biases of parent report, parents are still able to paint a relatively accurate picture of their child's behavior. However, it is still important to be aware of the potential flaws of parent-report measures when using them to measure child temperament.

Therefore, although biases do exist, parent-report measures of temperament still provide researchers with a relatively stable and accurate picture of child temperament (Bridges et al., 1993) and were used in the current study. More specifically, temperament was assessed via the Children's Behavior Questionnaire (CBQ; Rothbart et al., 1994; Rothbart et al., 2001), a parent report measure of child temperament. The CBQ identifies major constructs of temperament that are further split up into fifteen subconstructs (Rothbart et al, 2001). This bottom-up approach of temperament allows for explorations of each major temperamental construct by examining the specific homogenous subconstructs that make them up. The relationships among subconstructs help paint a better picture of the dimensions that affect the variability of the major constructs and thus, a better picture of individual temperament as a whole. More detailed exploration of the CBQ and its validity is given upon discussion of the methods of the current study.

Daycare and Temperament

Although many aspects of daycare itself are investigated as they relate to children's development, one important factor relating to the child cannot afford to be neglected. All children do not react similarly to time spent in daycare, which means that child temperament must be taken into account when studying daycare and its potential effects (Crockenberg, 2003).

Phillips et al. (2011) reviewed the literature examining individual differences in temperament and reactions to stress in relation to time spent in daycare. The authors stressed that it is becoming increasingly clear that the conditions of daycare need not be the focus of research; rather, the individual children experiencing the conditions should be emphasized. A number of studies have shown that longer hours spent in a daycare setting for children with difficult temperament proves to be much more debilitating than for those children with generally positive temperaments (Crockenberg & Leerkes, 2005; Watamura, Donzella, Alwin, & Gunnar, 2003). Thus, Phillips et al. (2011) explain that understanding both the positive and negative effects of daycare may rely on a more specific understanding of how a child's individual differences, such as their temperament and reaction to stress, interact with the daycare setting. With this knowledge, the authors propose that studies that find an effect of daycare should be interpreted with temperament in mind in order to be of most use to both parents and the advancement of the literature.

Luckily, there are a number of daycare studies that examine temperament and its relation to the daycare setting. As previously mentioned, these studies show that temperament can be a moderating factor on the impact of daycare on children's development. More specifically, these studies show that a number of negative temperamental characteristics are associated with poor reactions to time spent in daycare. Although the specific behaviors exhibited by children differ from study to study, they all represent a negative reaction to time spent in daycare in some form. For example, Crockenberg & Leerkes (2005) were able to link specific aspects of temperament to externalizing and internalizing behaviors exhibited by children spending long hours in daycare. When compared to temperamentally similar children, easily frustrated infants who spent long hours in daycare engaged in more externalizing behavior at 2½ years. Further,

children spending long hours in daycare who were highly reactive to novelty as infants engaged in more internalizing behavior when compared to similar children who did not spend time in daycare settings.

Additionally, teacher-reported social fearfulness (Watamura et al., 2003) and anxious and withdrawn behavior (Tout, Haan, Campbell, & Gunnar, 1998) have both been found to correlate with larger cortisol increases throughout the day among children attending daycare. Cortisol readings are a common method for capturing daycare's effects on children because cortisol is linked with the hypothalamic-pituitary-adrenocortical (HPA) system, which is sensitive to physical and psychological stressors (Dettling et al., 1999). The activity of this system can be measured through glucocorticoids, with cortisol being the primary glucocorticoid in humans (Dettling et al., 1999). The reaction of this system to stress is observed through increased levels of cortisol that are produced when the demands of a stressful situation exceed the individual's coping resources (Dettling, Parker, Lane, Sebanc, & Gunnar, 2000). Therefore, high cortisol levels that are maintained throughout the day indicate a high stress response to the daycare setting and can be interpreted in a similar manner as poor outward behavioral reactions.

Whereas the normal daily rhythm of cortisol tends to move from high levels in the morning to lower levels in the afternoon (Price, Close, & Fielding, 1983), the aforementioned studies have found the opposite, with levels increasing into the afternoon in the majority of children attending daycare (Dettling et al., 1999; Dettling et al., 2000; Tout et al., 1983). However, these studies not only found this atypical cortisol pattern, they also found correlations with even higher levels of cortisol in children with difficult temperaments. These higher levels of cortisol are usually exhibited through behaviors that correspond with various internalizing and externalizing problems. Therefore, although daycare may produce increased stress in some form

for many children attending daycare, children with difficult temperaments react even more poorly.

As previously mentioned, Dettling et al. (1999) found that specific temperamental characteristics were associated with greater increases in cortisol over the day in children enrolled in full-day group care, regardless of age. More specifically, these characteristics included shyness in boys as well as impulsivity, poor self-control, and aggression in both sexes. In addition, Dettling et al. (2000) found that children with high levels of negative affect and children with low levels of effortful control were more likely to exhibit high levels of cortisol during the course of the day in the daycare setting. Furthermore, it is noted that the influence of these temperamental characteristics at daycare is most likely due to greater challenges that the daycare setting presents because these same characteristics were not correlated with cortisol patterns for children at home or in other forms of childcare (Dettling et al. 2000).

Further investigation of the relationship between difficult temperament and daycare has even found temperament to be a moderator for the effects of quality of daycare (Belsky & Pluess, 2011). As discussed previously, quality of care seems to matter most for cognitive and academic development. However, when examining difficult temperament, it seems that temperament also may moderate socioemotional effects of quality of daycare. More specifically, a differential susceptibility relationship emerged. Children with difficult temperament exhibited more behavior problems with low quality of daycare; however, children with difficult temperament showed fewer problems with high quality care when compared to those with easy temperaments. Interestingly, the same results were not found for children without difficult temperament. This finding strengthens the notion that something inherent about the daycare

setting has a negative interaction with aspects of a child's difficult temperament, resulting in a poor behavioral or emotional reaction from the child.

The interaction of the daycare setting and aspects of a child's difficult temperament can be explained by "goodness-of-fit," a theory proposed by Thomas and Chess (1977). This model suggests that certain children are better "fit" for certain environments based on the interactions of their own characteristics (temperament) and the characteristics of the environment. For example, Churchill (2003) examined this idea by having teachers rate children's temperament as well as complete a measure that described what kinds of behaviors were tolerable and not tolerable in a classroom setting. These measures were then compared in order to create a goodness-of-fit between child and teacher. The results showed that goodness-of-fit was positively correlated with the children's cognitive as well as social outcomes. This finding demonstrates the benefits of goodness-of-fit and why parents should strive for it when considering daycare options for their child. However, this is not always an easy task for parents. In addition to problems with finding a daycare that matches a child's temperament, other resources such as time and money surely have a large impact on the daycare decisions of parents.

In another study examining this model, Coplan, Findlay, and Schneider (2010) do shed some more positive light on this issue for parents. First, in congruence with other studies, they did find that among all children rated most anxious at age 4 to 5 years, those who spent time in home-based care were significantly less anxious 2 years later when compared to children in center-based care (daycare). This finding supports the general argument that has been proposed thus far: children with difficult temperaments are more adversely affected by time spent in daycare. However, it also was shown that anxious children who had received no form of nonparental care were rated as more anxious 2 years later when compared to anxious children

who had received nonparental home-based care. Although not all children are negatively affected by staying at home, it does seem that the best fit for children who are anxious may be a form of home-based nonparental care. This suggests that there are other more positive alternatives to daycare for children rated as anxious. At the very least, this finding furthers the argument that daycare is not a good fit with all child temperaments.

Although all of these studies are useful in illustrating how temperament can interact with time spent in daycare, a problem still remains. Each of the aforementioned studies shows how negative temperamental styles can interact with time spent in daycare to produce more distress and negative behavior in these children, but the investigation stops there. What about additional effects that may stem from these results? It is well documented that children with difficult temperament are adversely affected by time spent in daycare, but how these findings interact with other aspects of a child's life, such as time spent with the parent, are less well known. The next section explores a part of this question, examining the literature on the relationship between time spent in daycare and parent-child interactions.

Daycare and Parent-Child Interactions

A parent-child interaction is one of many outcome variables analyzed in relation to time spent in daycare. However, findings regarding daycare's effects on parent-child interactions have been mixed, with various studies suggesting that daycare hinders interactions, has no detrimental effects on interactions, has periodic effects on interactions, and has only temporary effects on interactions (Shpancer, 2006). A few studies are examined in order to better understand the effects that time spent in daycare may have on parent-child interactions.

As previously mentioned, some studies have found that time spent in daycare has detrimental effects on parent-child interactions (Ahnert, Rickert, & Lamb, 2000; NICHD, 1999). For example, Ahnert et al. (2000) found that mothers of children ages one to two years who were in daycare during the day were less responsive to their children's distress signals (whining) when compared to mothers of children who did not spend their days in daycare. Daycare children and home-only children also differed in patterns of distress. Whereas home-only children maintained relatively stable and low levels of distress throughout the day, daycare children were more likely to whine in spurts: in the morning as well as when they were reunited with their mothers at the end of the day. According to Ahnert and Lamb (2003), children, especially those who experience high levels of distress at daycare, need support from their mothers to be able to stabilize their emotions at the end of the day. If this need is not met, distress felt by the child may carry over to the next day at daycare. Consequently, the child's emotional threshold may be lower, which could exacerbate the potentially stressful effect that the daycare setting can already have on the child, especially if he or she has a difficult temperament. Keeping this in mind, parents should try to interact sensitively and respond appropriately to their child's negative emotions at the end of the day, especially if the child is at higher risk for distress due to a difficult temperament (Ahnert & Lamb, 2003).

However, "interacting sensitively" and "responding appropriately" to a child's negative emotions may be easier said than done. According to a NICHD (1999) study, longer hours spent in daycare predicted less sensitivity shown by mothers in interactions with their children. Therefore, although children may need parents to be able to buffer their daycare-produced stress, parents may not always be able to. This, among other possibilities, could be due to stresses at work, demands of other responsibilities, or a misinterpretation of their child's distress signals

(Ahnert & Lamb, 2003). Regardless of the reason, these studies suggest that a parent's inability to properly deal with their child's daycare-related stress results in, or results from, poor interactions between parent and child. Additionally, a NICHD (1997) study examining daycare and child-parent attachment found that children with less sensitive and less responsive mothers were more likely to be securely attached if they spent less time in daycare and more time at home.

On the other hand, other studies have found that time spent in daycare can affect parent-child interactions in a positive way (Edwards, Logue, Loehr, & Roth, 1986; Roopnarine, Mounts, & Castro, 1986). More specifically, Edwards et al. (1986) compared 2- to 22-month-old home-reared children to similar aged children who spent time in daycare to examine whether or not daycare affected parent-child interactions. They found that the children in the daycare group actually elicited more warmth and proximity from their parents when compared to the home-reared group during similar interactions with their parents.

Although these studies shed some light on the potential effects that daycare can have on parent-child interactions, the results are inconclusive. Why do these mixed results exist? Shpancer (2006) suggests that "the actual (causal) effects of daycare on development depend in large measure on unknown variables, and on complex unmapped interactions between variables" (p. 228). One of these variables, according to Shpancer, happens to be temperament. Perhaps a child's temperament can explain some of the variance in the findings concerning daycare's effects on parent-child interactions. Unfortunately, very few studies take this into account when examining this interaction. For example, in the Edwards et al. (1986) study, temperament was not only not included in their analysis, it was not even measured. Without knowledge of the temperamental characteristics of the sample, these results are hard to interpret. First, there could

be a fundamental difference between the two groups (daycare versus no daycare) in terms of temperament. Although random sampling may have been utilized, there is always the chance of random selection failure. Additionally, it may be the case that more temperamentally difficult children are more likely to be in one group over the other. Either way, this is problematic because a between-group difference in temperament might have explained why one group engaged in more positive interactions than the other. This issue could be fixed by measuring temperament, which is something that most studies manage to do. The second issue holds a bit more relevance. Without including temperament in a study's analysis, it is impossible to gauge how accurate the results are. Are all children in an experimental group the same? Do all children react to daycare similarly? The answers to both of these somewhat obvious questions illustrate why including temperament in the analysis of any daycare study is of the utmost importance.

The previous NICHD (1999) study, which found that more hours in daycare predicted less maternal sensitivity during an interaction, did include temperament as a controlled variable. Although not including temperament as an experimental variable, controlling for temperament acknowledges that it is a variable that has a tendency to be associated with parent-child interactions. Regarding temperament, the authors note:

> "…the child-care effects on mother-child interaction (for the behavior of mothers and children alike) were on the same order of magnitude as other child and maternal factors (child difficult temperament and maternal depressive symptoms) known to be reliable associates of mother-child interaction processes" (p. 1410).

This finding is of importance for the current study. Although not included in the main analysis, temperament was shown to be equally impactful on parent-child interactions when compared to daycare's impact on them. With this in mind, paired with the knowledge that temperament can have an effect on children's reactions to daycare, examining the effect of the interaction between temperament and daycare experience on parent-child interactions seems both logical and interesting.

Temperament and Parent Child Interactions

At this point, the literature examining daycare and temperament in combination as well as the literature examining daycare and parent-child interactions in combination have both been discussed. This leaves one combination relating to these three constructs: parent-child interactions and temperament. When observing a parent-child interaction, it is important not to lose sight of the fact that any observed parental behavior, or change in behavior, may simply be due to the observed behavior, or change in behavior, of the child (Edwards et al., 1986). More notably, a child's temperament can have a direct effect on the behavior of a parent during a parent-child interaction, as temperament characteristics have been found to be more strongly related to mother behaviors than child behaviors during an interaction (Webster-Stratton & Eyberg, 1982). However, it would be wrong to think that these temperament characteristics are unaffected by the parent's behavior. Although very much genetically based, child temperament can also be affected by a variety of environmental characteristics, such as parental sensitivity and responsivity (Wachs, 1999). Therefore, there seems to be a circular effect at play during a parent-child interaction, with the exact causality of parent and child behavior perhaps hard to pinpoint. Child temperament may have an effect on parent behavior; however, at the same time, this temperament may be influenced by the parent's behavior as well.

Kivij□rvi, R□ih□, Kaljonen, Tamminen, and Piha (2005) investigated this relationship during a parent-child interaction, focusing on maternal sensitivity as it related to child temperament. Two groups of mothers emerged based upon their sensitivity during the interaction. More sensitive mothers were able to respond appropriately to their infant's cues, were more connected with their child, and were more emotionally available. Less sensitive mothers, on the other hand, were not as able to respond to their infant's cues, were less able to connect with their child, and were less emotionally available. Infants of more sensitive mothers were less active, had fewer problems in mood and social behavior, and expressed more pleasure, positive affect, and happy mood when compared to infants of less sensitive mothers. Even though temperament is a set of inherited characteristics, this finding illustrates the influence that parental factors can still have on some aspects of child temperament. At the same time, shared genes must always be considered as well, as more sensitive mothers may give infants genes that correlate with easier temperament. Nevertheless, both parental factors, genetics and behavior, appear to have the potential to affect child behavior.

This finding, that parent behavior can have an effect on child temperament during an interaction, is not uncommon. Parent-child interactions described as more harmonious, complementary, and engaging have been found to correlate with changes in child emotionality from three months to nine months, both from low positive to high positive and from high negative to low negative (Belsky, Fish, & Isabella, 1991). Rettew, Stanger, McKee, Doyle, and Hudziak (2006) examined the interaction of child and parent temperament to better understand its link to child behavior problems and psychopathology. Interestingly, they found that although some child temperament traits could predict behavior problems, very few parental traits had the same effect. The majority of parental characteristics were only significant predictors when

paired in an interaction with child traits. This finding seems to suggest that parental behaviors may only have an effect on child behavior when paired in combination with them, thus further illustrating the complexity of parent-child interactions. Parent behavior may matter in relation to predicting child behavior, but perhaps only when interacting with the child behavior.

This idea reflects the other side of the interaction: how temperament can affect parent's behavior. As alluded to earlier, Webster-Stratton and Eyberg (1982) found that children with a more active/difficult temperament had mothers who were more negative in affect, more nonaccepting, and more submissive during an interaction. The authors suggest that this could be due to the fact that these children demand so much of their mothers but give very low levels of positive reinforcement in return. Although this very well may be the case, the other side of these interactions must always be considered. How does one truly know whether a child is affecting the parent's behavior or if it is the parent's behavior that is affecting the child? How much of a child's temperament is affected by the parent's behavior during an interaction? How much of parent behavior relies on the child's temperament during the interaction? To further the complexity, it is important to remember that shared genes between parent and child may also have a large effect on the behaviors observed during an interaction. Upon review of the relevant literature, it seems that parent-child interactions are a result of some type of combination of factors, with parents and children affecting one another to an observable degree, both behaviorally and genetically.

Parents and children affecting one another in a circular fashion can be further explained through the transactional model of development. This model, proposed by Arnold Sameroff, explains that child and environment are both dynamic entities which continuously affect one another in a series of transactions (Sameroff, 2009). More specifically, the transactional model

describes a bidirectional relationship that exists between organism and environment, with each having the ability to affect one another at all times. Further, Sameroff explains that the source of a child's behavior can always be explained as a product of the transactions between themselves (their phenotype), their external experience, and their genotype (their biology). For the purposes of this study, an important aspect of the child's environment worth examining is the child's parents. Therefore, this model, although not limited to the relationship between parent and child, clearly demonstrates that child and parent biology, as well as parent and child behavior, can be examined as potential contributors to the quality of parent-child interactions.

Parent-child interactions are clearly made up of a large number of variables. However, what happens when one more variable is added, namely daycare experience? It has been shown that daycare can negatively affect children with difficult temperaments (Crockenberg & Leerkes, 2005). It has also been shown that more time spent in daycare can negatively affect a mother's ability to buffer the stress that these children experience in daycare, thus worsening their interactions (Ahnert & Lamb, 2003). It has just been illustrated that during a parent-child interaction, both parent and child can have an effect on one another and the interaction as a whole (Kivij□rvi et al., 2005; Webster-Stratton & Eyberg, 1982). Although the quality of an interaction between parent and a child with difficult temperament who spends lots of time in daycare may seem simple to predict based on all of these results, very few studies have actually tested this hypothesis. The current study hopes to solve this problem and begin to fill the gap in the literature.

Although daycare experience and temperamental behavior exhibited by both parent and child can affect interaction quality, genetics must also be discussed. Temperament is a by-product of both genes and environment, meaning that genetics need to be examined when

investigating temperament and its role in affecting parent-child interactions. Even beyond its effect on temperament, genetic make-up may play a role in interactions as a whole, and is therefore discussed further in subsequent sections. This study used a twin sample, allowing for investigations of both genetic and environmental effects on outcome variables.

Molecular Genetics and Interactions

Although specific genes were not examined in this study, a few studies have found specific genes that seem to play a role in different interaction behaviors. For example, genetic variations that affect the μ-opioid receptor, which plays a role in the reinforcement system through the release of opioids during interactions, have been found to influence social behavior with one's parents in animal models (Copeland et al., 2011). More specifically, mice lacking the OPRM1 receptor gene illustrate deficits in preference for maternal cues and maternal-induced ultrasonic vocalizations (Moles at al., 2004), whereas rhesus monkeys with a certain variation of the OPRM1 gene show increased vocalization during periods of maternal separation and more preference for the mother upon her return (Barr et al., 2008). In humans, a specific variant of the μ-opioid receptor has been found to correlate with higher enjoyment and fewer arguments during parent-child interactions, but only when parents had a history of mental, substance, or criminal problems, suggesting a protective influence of the gene variant (Copeland et al., 2011). Additionally, DiLalla et al. (2009) examined children with a specific allele of the dopamine receptor gene (DRD4) in their interactions with their parents. Parents whose children had this allele were less sensitive during the interaction, with children's genotype also interacting with parent's prior sensitivity to predict later externalizing problems. Each of these studies illustrates the potential contributions of specific genes to interactions between parents and children, and although specific genes were not examined in the current study, these findings support the

general examination of behavioral genetics via the twin method when investigating parent-child interactions.

Behavioral Genetics

Behavioral genetics is a field of study that examines the potential influence of genetics and environment on a variety of different traits and behaviors. The first and most basic way to assess genetic influence is by comparing the expression of a given trait between family members. Given the knowledge that parents pass on 50% of their genetic material to their offspring and that siblings share 50% of their genes with each other, researchers can begin to estimate the contribution of genes to the behavior or trait that they are interested in by comparing family members to one another. However, assessing familial genetic patterns poses some problems to researchers because families not only share genes, they also share their environment. Therefore, it is difficult to determine whether it is genes or environment that is contributing most to a given trait. This problem can be dealt with through another method: adoption studies. These studies allow for estimations of both genetic and environmental influences on behavior through the examination of different relationships involving the adopted individual. For example, adopted children can be compared to their genetic parents who no longer live with them. Any similarities between biological parent and offspring can be attributed mostly to genetic contributions, although prenatal environment may also play a role. Additionally, adopted children can also be compared to an unrelated individual that they now live with. In this method, since the environment between the two is shared, any similarities between them can be largely explained by shared environment, with any differences potentially due to nonshared environment or measurement error. The third method of assessing genetic and environmental influence on traits

or behaviors is the twin study, and because it is utilized in the current study, it is explained further in the subsequent section.

Twin Studies

There are two types of twins, monozygotic (MZ) and dizygotic (DZ), and knowledge of the differences between them allows for understanding of how twin studies can provide information concerning genetic and environmental influences on behavior. MZ twins derive from one single zygote (egg) and are therefore genetically identical. Moreover, for any trait that is thought to have a strong genetic influence, similarity between MZ twins is thought to represent this genetic influence (Plomin, DeFries, McClearn, & McGuffin, 2008). On the other hand, although DZ twins also develop at the same time, they derive from separately fertilized eggs. Consequently, these twins share only about 50% of their genetic material, like any other sibling pair. Whereas MZ twins are virtually always the same sex, DZ twins are only the same sex in 50% of cases (Plomin et al., 2008). Twins share more similarities in environment, both prenatal and postnatal, when compared to siblings. Since twins share the womb at the same time, prenatal environment can usually be ruled out as a contributor to any observed differences in later traits or behavior, unlike with siblings. However, it is worth noting that MZ twins may experience some differences in prenatal environment when compared to DZ twins due to greater prenatal competition caused by sharing the same zygote in the womb (Plomin et al., 2008). Nevertheless, prenatal environments are more similar for twins than they are for siblings. Additionally, postnatal environments are also more similar for twins. This is mostly due to the fact that twins will experience all events in their environment at the same age as their co-twin, unlike other siblings who are different ages.

Twin Study Methodology

The knowledge of genetic similarity between twins, either MZ or DZ, allows researchers to estimate heritability, a statistic of genetic effect size. More specifically, heritability is the proportion of phenotypic variance that can be accounted for by genetic differences among individuals (Plomin et al., 2008). It is worth emphasizing that heritability is not the genetic contribution to an individual phenotype; rather, it is the genetic contribution to the variance of phenotypes among individuals. Among a population of individuals, all traits and behaviors will be a product of genes and environment. However, although both genes and environment contribute to all traits and behaviors, differences among individuals can be explained by differential contributions of genetics and environment among the population. In other words, genes and environment contribute to each individual differently, and heritability is a method to determine the genetic role of the variance within the population (Plomin et al., 2008).

When examining different outcomes in twins, it is important to understand what any given trait is influenced by. First, a trait can be due to additive or other types of genetic influences. As has been discussed, knowledge of the amount of shared genetic material between twins comes from knowing the type of twins they are, with MZ twins sharing nearly 100% of their genetic material and DZ twins sharing roughly half of their genes. The second contributor to a given trait is shared environment. All shared environmental influences between twins cause twins to become more similar. On the other hand, the third contributor to a given trait is the nonshared environment, which accounts for half of the variance in family resemblance (Plomin et al., 2008). All nonshared environmental influences between twins are thought to contribute to differences between twins. Therefore, it is assumed that similarities between twins are a result of

both shared genetics and shared environment, whereas differences between twins are a result of nonshared environmental influences and nonshared genes (Plomin et al., 2008).

When examining environmental influence among twins, the equal environments assumption must be taken into account. This theoretical supposition explains that environmentally caused similarity is roughly the same for both MZ and DZ twins (Plomin et al., 2008). In other words, MZ and DZ twins are assumed to both experience their shared environments to the same extent. If this assumption were violated due to MZ twins experiencing more similar environments than DZ twins, estimates of genetic influence would be inflated, but only if these similar environments are correlated with the psychological outcome of interest (Plomin et al., 2008). Some studies suggest that there are indeed problems with the equal environments assumption. For example, some researchers have found that MZ twins are treated differently by parents, teachers, and peers, with MZ twins also more likely to play with the same peers and dress alike (Richardson & Norgate, 2005). However, as previously mentioned, researchers must be sure that the identified shared environment is relevant to the behaviors or traits being studied, which is not always the case. Nevertheless, other researchers question the assumption because MZ twins may be more likely to choose more similar environments due to their increased genetic similarity when compared to DZ twins (Eriksson, Rasmussen, & Tynelius, 2006). In other words, their experiences are genetically driven and thus differ from the experiences of DZ twins. However, others have argued that since these differences are not driven environmentally, this is not actually a violation of the assumption (Eaves, Foley, & Silberg, 2003). Despite these potential concerns, the equal environments assumption has been upheld in a number of twin studies (Derks, Dolan, & Boomsma, 2006; Cronck et al., 2002;

Walker, Petrill, Spinath, & Plomin, 2004), although remaining aware of the potential concerns of this assumption still holds importance when running any twin study.

Although the current study did not examine the heritability of specific traits, the use of a twin sample still offers many advantages. The use of MZ and DZ twins allows researchers to examine both genetic and environmental effects on a variety of different outcome variables. In this case, considering genotype is especially important because temperament is largely genetically based. Examining twin pairs allows for investigations into similarities and differences in temperament between and within sets of MZ and DZ twins. At the same time, observing how the environment (e.g. amount of daycare experience) may differentially affect MZ and DZ twins also can shed some light on how daycare and temperament may interact, and in this case, how they may affect parent-child interactions. This examination of genes and environment in combination is known as gene-environment correlation (rGE). There are three types of gene-environment correlations (passive, evocative, and active) and all three refer to a situation in which a person's genotype and environment become correlated (Franic, Middeldorp, Dolan, Ligthart, & Boomsma, 2010). Active rGE refers to when a child inherits both their genes and their environments from their parents, meaning that their genes and environment are correlated and cannot be easily disentangled when examining the child's phenotype. Evocative rGE refers to when a child's genetic makeup evokes certain environmental stimuli, resulting in genes and environment being correlated. Lastly, active rGE results correlated genes and environment when a child's genetic makeup drives the child to seek out certain environmental stimuli that are concordant with their genes. Although the specific details of how these mechanisms may be taking place in the daycare setting will not be examined in the current study, the possibility of rGE occurring will be examined.

Summary

The current study examined child temperament, time spent in daycare, and parent-child interactions among a sample of four- and five-year-old twins. First, the potential interactive relationship between temperament and time spent in daycare was explored by examining its relationship with parent-reported behavior problems. Second, this relationship between temperament and daycare was investigated in relation to sensitivity shown by parents during a parent-child interaction, which serves as the major focus of the study. Next, the twin methodology was added to analyses in order to examine the effects of genes and environment on the constructs in the study. Parent-child interactions were examined among MZ twins only in order to hold genes constant, allowing for other factors, such as temperament, to be explored as potential contributors to differential sensitivity shown to co-twins by parents. Temperamental differences between MZ and DZ co-twins also were investigated in relation to time spent in daycare in order to determine whether daycare acts more as a shared or nonshared environment, as well as to test for potential gene-environment correlations for twins at daycare.

Specific Hypotheses

Hypothesis 1: Children with more difficult temperament and who experience more daycare would be rated as having more behavior problems by parents.

> Hypothesis 1a: Children rated as more temperamentally shy and who also experience more daycare would be rated as exhibiting more internalizing problems.
>
> Hypothesis 1b: Children rated as more temperamentally active and impulsive and who also experience more daycare would be rated as exhibiting more externalizing problems.

Hypothesis 2: Children with greater risk from either difficult temperament or increased daycare experience would have less sensitive parents.

Hypothesis 2a: Children with more difficult temperament (temperamentally shy or active/impulsive) would have parents who are less sensitive during their interactions.

Hypothesis 2b: Children who experience more daycare would have parents who are less sensitive during their interactions.

Hypothesis 2c: Beyond these main effects, children who have both a difficult temperament and more daycare experience would have the least sensitive parents during their interactions.

Hypothesis 3: This hypothesis examined parental sensitivity among MZ twin pairs in order to control for genetic effects. More specifically, it compared parents who were concordant on sensitivity across both twins to those who were discordant on sensitivity. This hypothesis stated that when parents treated their children more similarly (concordant on sensitivity), children would be more temperamentally similar, whereas twin pairs whose parents treated them differently (discordant on sensitivity) would be more temperamentally different. One potential explanation could be shared genes, so therefore only MZ twins were considered for this hypothesis. By holding genes constant, other potential contributors to parental sensitivity (i.e., temperament) could be explored.

Hypothesis 4: This hypothesis examined the effect of time spent in daycare on temperamental similarity or dissimilarity among twin pairs, as well as the potential genetic influence on this effect.

Hypothesis 4a. Across all twin pairs, more time spent in daycare would correlate with twin pairs being less alike temperamentally.

Hypothesis 4b. The correlation between daycare and temperamental dissimilarity would be significantly stronger for DZ pairs than for MZ pairs, suggesting a genetic influence on a child's reaction to the daycare setting.

CHAPTER 3

METHODS

Participants

Participants used in this study were previous participants who had been tested for the Southern Illinois Twins and Siblings Study (SITSS; DiLalla, 2002; DiLalla, Gheyara, & Bersted, 2013). Once families were contacted about the longitudinal study and expressed interest in participating, twins were brought in once every year through age 5 and were given measures to assess their social and cognitive development. Although all participants in the study have already previously been tested, testing for SITSS is ongoing. Also, despite testing twins every year up to age 5, this study only uses data from twins at 4 and 5 years old. The total possible sample consisted of 151 families of twin pairs and triplet sets who were tested at both ages. However, the Children's Behavior Questionnaire, one of the major measures used in this study, was not administered until 2006, meaning that the majority of these pairs were not administered every measure needed for analyses.

Consequently, 60 families (57 twin pairs, 3 triplet sets) were available for analyses. However, because each hypothesis required data on a different set of variables and a few families were missing data, each hypothesis has its own slightly different sample (see Table 1). Two families from the original 60 were missing the CBCL and therefore were not used in analyses of hypothesis 1. One twin pair and one triplet pair from hypothesis 1 did not have parent-child interaction data due to technical difficulties with the camera at the time of testing, which explains the two different samples between hypotheses 1 and 2. To avoid dependency of sample, one twin was randomly selected from each twin or triplet pair for these hypotheses. Hypotheses 3

and 4 used both children from all pairs because they utilized the twin method. Hypothesis 4 had one more MZ pair than hypothesis 3 because that pair did not have parent-child interaction data due to technical difficulties with the camera at time of testing. Prior to analyses, data were checked for sex differences on internalizing behavior, externalizing behavior, and parental sensitivity. These results are presented in Chapter 4.

A power analysis was calculated using G*power (Faul, Erdfelder, Buchner, & Lang, 2009) to determine the appropriate sample size needed to detect a relationship between variables for each hypothesis. Estimates of small, medium, and large effect sizes were obtained for all hypotheses because exact effect sizes were not apparent from the literature. Results are also shown in Table 1. Overall, only large effect sizes were able to be detected given the current samples for each hypothesis

Measures

Demographic Questionnaire

All families were administered a demographic questionnaire (see Appendix A) assessing background information such as race, family structure, parental age, parental education level, and parental occupation. An overall socioeconomic status (SES) score was created from information collected through the demographic questionnaire by averaging maternal and paternal education, maternal and paternal occupation, and family income. Maternal and paternal education was rated on a 7-point scale (1 = some high school or high school degree; 3 = some college; 5 = college degree; 7 = advanced training beyond college degree). Maternal and paternal occupations were rated via the Hollingshead index (1 = unskilled labor, to 7 = high level professional; Bonjean, Hill, & McLemore, 1967). Lastly, family income was rated on a 12-point

scale (1 = less than $5,000, to 12 = greater than $55,000). Descriptives of these variables within the study's sample can be seen in Table 2.

Children's Behavior Questionnaire (CBQ)

The Children's Behavior Questionnaire (CBQ; Rothbart, et al., 1994; Rothbart, et al., 2001) is a standardized caregiver report measure of temperament designed for early to middle childhood, specifically for children 3 to 7 years old. Parents complete the CBQ for SITSS when children are 4 years old. The CBQ consists of 195 items that describe a wide range of child emotion and behavior. Parents were asked to rate their child according to each item during the past 6 months on a scale ranging from 1 (extremely untrue of your child) to 7 (extremely true of your child), with an additional Not Applicable response also available (Putnam & Rothbart, 2006). Examinations of the CBQ (Rothbart et al., 2001) have shown that it illustrates adequate internal consistency (Cronbach's alpha range from .64 to .92, mean of.73 for 4- and 5-year-olds), stability across time (*r* mean of .65 for mothers and .63 for fathers across scales for ages 5 to 7), as well as convergent validity between parents (*r* range from .28 to .79, mean agreement of .51 across all scales) and from laboratory observations of temperament in infants that accurately map onto CBQ scales at age 7. Within the entire SITSS sample at age 4, Cronbach's reliability alphas range from .55 to .89, mean of .70. Individual differences are assessed on 15 primary temperament characteristics: Positive Anticipation/Approach, Smiling/Laughter, High Intensity Pleasure, Activity Level, Impulsivity, Shyness, Discomfort, Fear, Anger/Frustration, Sadness, Reactivity/Soothability, Inhibitory Control, Attentional Focusing, Low Intensity Pleasure, and Perceptual Sensitivity. Although the CBQ was not designed with a larger factor structure in mind, a three factor structure has become reliably apparent: Extraversion (Surgency), Negative Affectivity, and Effortful Control (Putnam & Rothbart, 2006). Extraversion (Surgency) is

characterized by high scores on the Impulsivity, High Intensity Pleasure, Positive Anticipation, Smiling/Laughter, and Activity Level scales and lower scores on Shyness. Although not examined in the current study, this factor shows adequate reliability within the entire SITSS sample with a Cronbach's alpha of .72. Negative Affectivity is made up of high scores on the Sadness, Fear, Anger/Frustration, and Discomfort scales, as well as lower scores on Reactivity/Soothability. This factor also has a Cronbach's alpha of .72, showing adequate reliability within the SITSS sample. The final factor, Effortful Control, is characterized by high scores on the Inhibitory Control, Attentional Focusing, Low Intensity Pleasure, and Perceptual Sensitivity scales. This factor shows moderate reliability within the SITSS sample, with a Cronbach's alpha of .64. These second-order factor reliabilities, along with the reliabilities of the first-order CBQ factors, can be seen in Table 3.

Although a few of this study's hypotheses refer to a "difficult" temperament, Rothbart argues against this label (Rothbart, 1982). This is mainly due to the fact that certain behaviors may be appropriate in some situations and not others. Additionally, there are costs and benefits to having any temperamental characteristic, not just ones deemed as "difficult," so labeling children as such may imply that they are at risk for later problems when they actually may not be. However, "difficult temperament" has been used throughout this proposal, both for simplicity's sake and because the majority of other researchers have used it (e.g., McDevitt & Carey, 1978). For the current study, difficult temperament refers to children who are rated highly on shyness or activity and impulsivity. Upon review of the various studies cited in this proposal, the use of these characteristics seems logical, as the majority of the studies refer to these characteristics in some form when using the term "difficult temperament." For example, difficult temperament has been used to describe poor self-control or impulsivity (Dettling et al.,

2000), shyness (Dettling et al., 1999), high activity (Crockenberg & Leerkes, 2005), and fearfulness, a characteristic similar to shyness (Watamura et al., 2003).

Although two major temperament patterns (active/impulsive and shy) were hypothesized, temperament was additionally conceptualized in a couple of other ways in order to more fully explore the potential relationship between temperament and daycare, as suggested by Phillips et al. (2011). Both of the original temperament variables were explored prior to analysis via bivariate correlations between all of the CBQ variables, a factor analysis of a subsample of CBQ variables, and Cronbach's alpha analyses. The principal components factor analysis included 8 CBQ variables thought to represent temperaments that may correspond with internalizing problems (shyness, sadness, reactivity, discomfort, fear) and externalizing problems (high activity, impulsivity, high intensity). Bartlett's Test of Sphericity was significant, χ^2 (28) = 145.94, $p < .01$. Results indicated that all eight CBQ variables had communalities greater than .3, confirming that each shared some common variance with the other included variables. Two factors with eigenvalues greater than 1 were extracted that together accounted for 58.35% of the variance in the sample used for hypotheses 1 and 2. The first factor was the factor thought to correspond with internalizing, and the second was thought to correspond with externalizing (see Table 4). Both factors are explained in more detail below.

Activity and impulsivity, the items making up the first proposed temperament variable, were first explored. Examination of the factor analysis revealed that after varimax rotation, factor loadings of activity level (.82), impulsivity (.81), and high intensity (.72) all combined to create the second factor that uniquely accounted for 24.45% of the variance. Moreover, these three variables were found to be adequately reliable with a Cronbach's alpha of .73. Therefore, the original temperament variable (activity and impulsivity) was modified to include high

intensity as well, resulting in a variable composed of the sum of a child's score on activity level, high intensity, and impulsivity. This temperament composite variable was thought to correspond with possible externalizing problems, was normally distributed, and is referred to in further analyses as "energy level."

Similarly, shyness, the other proposed temperament construct, also was explored. Although shyness alone was still used as hypothesized, two additional temperament variables thought to also represent a temperament that may correspond with internalizing problems were created. Factor loadings from the principal components factor analysis revealed that after varimax rotation, sadness (.80), discomfort (.70), reactivity (-.71), and fear (.61) were the four highest items that combined to create the first factor, uniquely accounting for 33.9% of the variance in the sample. Further, after reversing reactivity scores, this factor was found to be moderately reliable, with a Cronbach's alpha of .69. Therefore, a composite variable was created by summing scores on sadness, discomfort, reactivity/soothability (reversed), and fear and was thought to represent depressed mood or anxiety, possibly corresponding with internalizing behaviors. This variable was normally distributed and referred to in further analyses as "depressed/anxious."

A correlation analysis prior to running the factor analysis showed that shyness and impulsivity were highly correlated, $r(59) = -.60$, $p < .001$, much more so than the other temperament items, which all had correlation coefficients in the .3 range or lower. Also, although shyness was the fifth highest item to load onto factor 1 in the factor analysis (.59), impulsivity did not load highly (-.23). Moreover, as previously mentioned, the first factor seems to represent a temperament that is more related to depressed mood and anxiety. Shyness, on the other hand, does not seem to fit with this factor conceptually. Rather, its relationship with

impulsivity makes more sense, perhaps representing a more behaviorally inhibited form of temperament, as opposed to the more "pathological" or "outward" expression of temperament captured in the first factor. For instance, children characterized by the first factor seem to be more likely to react with negative affect to new or uncomfortable situations, whereas children who are shy and not impulsive may simply avoid the situation quietly. Therefore, these two variables were combined by reversing impulsivity scores and summing them with shyness scores to create an additional, but conceptually distinct, *post-hoc* temperament variable also thought to correspond with internalizing behavior. This factor was found to be reliable with a Cronbach's alpha of .75, was normally distributed, and was used in further analyses as "reticence."

Child Behavior Checklist (CBCL)

The CBCL (Achenbach & Rescorla, 2001) is a standardized caregiver report measure of child behaviors and emotional problems for children between ages 6 and 18 years. Parents fill out the CBCL for SITSS when children are five years old. Parents are asked to rate their child according to 113 items with a 0 (never true), 1 (sometimes true), or a 2 (often true) during the past 6 months. Taken together, these items make up 8 subscales, including withdrawal problems, somatic complaints, anxious/depressed, social problems, thought problems, attention problems, delinquent behavior, and aggressive behavior. Examinations of the CBCL (Achenbach & Rescorla, 2001) have shown that these scales demonstrate high test-retest reliability (r's range from .95 to 1.00), high inter-rater reliability (r's range from .93 to .96), and adequate internal consistency (Cronbach's alpha range from .78 to .97). Furthermore, the CBCL has demonstrated adequate content and criterion validity (items discriminate between demographically similar referred and nonreferred children, $p < .01$; (Achenbach & Rescorla, 2001), as well as strong construct validity through predictions of long-term outcomes and similar results in other

measures. In addition to these subscales, two higher-order scales (Internalizing Problems and Externalizing Problems) also exist and were utilized in the study (Achenbach & Rescorla, 2001). The internalizing scale demonstrates high test-retest reliability (r = .91) and excellent internal consistency (Cronbach's alpha = .90). The externalizing scale also demonstrates both high test-retest reliability (r = .92) and excellent internal consistency (Cronbach's alpha = .94). Within the SITSS sample, the internalizing scale has a Cronbach's alpha of .78 and the externalizing scale has an alpha of .89.

Daycare History Questionnaire

Parents also were asked to fill out a Daycare History form (DiLalla, 1998; see Appendix A) that provides information concerning the child's daycare history since birth. Parents were asked to indicate what type of daycare their twins had been in or were currently enrolled in (e.g., center-based, in-home), for how long and at what ages they had been attending, and for how many hours per week they were attending. The types of care that were considered as "daycare experience" for this study were any type of out-of-home setting (prekindergarten, informal church daycare, and licensed daycare). Responses on this form were aggregated to create a Total Months of Daycare variable that reflects the number of months that a child has been in daycare up until age 5. This variable was used in all analyses that reference time spent in daycare. This form was filled out when twins within the sample had reached age 5.

Zygosity Assessment

Zygosity was determined in two ways, through buccal cell collection and parent and rater report (see Appendix A). The majority of the current sample has had buccal cells collected. This collection occurred three times during testing: before the twins began testing, after one twin

was finished, and once more when both twins had finished. Before collection, parents were given information on the purpose of collecting genetic material, the potential risks and benefits, and our confidentiality process. Samples were collected by swabbing the inside of both cheeks for 20 seconds on all three occasions. Once the study was complete, these samples were labeled and immediately frozen until they were able to be analyzed.

Zygosity also was assessed through parent and lab assistant ratings of certain characteristics of each twin pair based on a questionnaire by Nicholas and Bilbro (1966). The parent form was included in the packet of questionnaires that parents complete before the study, whereas the lab assistant form was filled out during the testing session. Both forms include characteristics of each twin such as hair color and eye color and are scored on a scale from 1 (very similar) to 5 (not at all similar). Further, parent forms include a question about whether or not the twins are ever mistaken by relatives, and lab assistant forms ask if they get the twins mixed up at all during the testing session. A zygosity score of either monozygotic (MZ) or dizygotic (DZ) was given based on the scores given for all characteristics. The first level of scoring focuses on hair color, hair curliness, and eye color; if distinctively different, the twin pair would be categorized as DZ. If there were no such differences and it is reported that the twins are repeatedly mistaken by parents or relatives, an MZ score would be given at the first level. Subsequent scoring levels that examine more subtle differences in hair and eye color and whether or not twins are mistaken by close friends or acquaintances are available if zygosity cannot be determined after the first level. For 122 same-sex twin pairs within the SITSS with both buccal cell and zygosity form information, there is a 94% accuracy match between the two measures.

Parent-Child Interaction

At the end of the testing session, one parent was asked to bring both children into the testing room to be videotaped during a ten-minute triadic parent-child interaction. Parents were given a puzzle task dependent on the twins' age to play with. After the interaction was complete, the recording was later watched and coded for a number of different behaviors exhibited by both parent and child in dyads, not as one triad. This procedure was completed by trained undergraduate raters who must attain 70% or better inter-rater reliabilities before they are allowed to code. There are currently 3 trained parent-child interaction coders. Each coder only codes one twin from each pair, in order to protect against coding biases that would make twins seem more similar than they actually are. During coding, the rater gives the parent and child an individual score on each measure every minute, for a total of ten scores on each measure. The scores are then combined to form an overall score on that measure. Two sets of overall scores were created, one for each parent-child dyad. For the purposes of the current study, the parental sensitivity rating was used. A score of one is given if the parent appears to be sensitive to the child's requests or emotions, is responsive to the child's attempts to engage the parent, is attentive to the child's mood, or allows the child to work on the task uninterrupted, as long as the parent is not ignoring the child. A score of two is given if the parent exhibits some sensitivity to the child's feelings and emotions and shows variable or delayed responses to the child's attempts to engage the parent. A score of two is also given if the parent attempts to try to make the child do something that they do not want to do. A score of three is given if the parent shows little sensitivity or responsiveness to the child, giving little support or response to the child's emotions, feelings, and behavior. A score of four is given if the parent completely lacks

sensitivity and responsiveness to the child, failing to read the child's cues and respond appropriately to the child's feelings, emotions, and behavior.

Procedure

Twins are recruited for the SITSS via flyers, the SITSS website, participating families' referrals, and through letters sent in the mail once births are announced in the local paper. Once a family has indicated interest in the study, parents are contacted in order to schedule a testing session at the SITSS laboratory on the Southern Illinois University campus. Testing sessions are scheduled around the twins' birthdays, with younger children coming in within a week of their birthdays and older children coming in within the month. Once scheduled, a packet of questionnaires assessing child temperament, zygosity (if same-sex twins), demographic and family information, home environment, and daycare information is mailed to the family. Specific contents of the mailing packets are dependent on the age of the twins, differing slightly from year to year. These questionnaires are completed by a parent before their visit to the lab and are collected upon arrival.

Before testing, all families are given information on the purpose of the study, any potential risks and benefits, and confidentiality. Once consent to participate is given, twins are able to begin the testing process. To begin testing, one twin is brought into a separate testing room with a graduate student tester. The room is empty except for a small table and two chairs. The tester then engages the twin in a number of different tasks meant to assess both social and cognitive development. Specific tasks are dependent on the twin's age at testing. This procedure is completed with the second twin as well. Following the completion of these tasks by both twins, the parent present at the study is then asked to engage in a 10-minute parent-child

interaction with both twins at the same time. This interaction is filmed and takes place in the same testing room as the graduate student testing. At conclusion of the study, children are given toys for their birthdays and families are thanked for their time. All questionnaires are then entered into a database and locked in laboratory filing cabinets.

CHAPTER 4

RESULTS

All data were double-entered by undergraduate assistants in the lab and cleaned prior to analyses. Each variable also was analyzed for skewness prior to analyses. When transformations were necessary, all variables were first square rooted. If still skewed, the natural log and square of each variable was taken and assessed. Of the CBQ variables that were used, only two required transformations (Low Intensity & Perceptual Sensitivity). Both were square rooted and were no longer skewed. All CBCL variables were positively skewed. The two variables of interest, internalizing and externalizing problems, were transformed and no longer skewed: the natural log was taken for internalizing problems and the square root was taken for externalizing problems. The majority of the daycare variables were positively skewed. A square root transformation was performed on total months of out of home care and resulted in positive skew, but to a lesser extent. Therefore, its square root was used for analyses, as all other transformations resulted in greater skewness. Examination of the out-of-home care variable revealed that 25 families predominantly used center-based licensed daycares, 25 families predominantly utilized prekindergarten, and four families used informal church care. However, many families utilized two types of out-of home care: five families placed their children in both informal church care and licensed daycares, whereas 18 families used licensed daycares as well as prekindergarten.

The only parent-child interaction variable of interest was parental sensitivity. Due to its non-normal distribution and minimal variability, the equal-area method of transforming a set of scores into a more normal distribution was used in order to categorize the variable (Darlington, 1997). To do this, twins were placed into one of five groups depending on the sensitivity shown

by their parent during the interaction. The cutoffs for each group were determined by examining a frequency table of the parental sensitivity variable. If their parent received a score of 1 (most sensitive), they were placed in group 1 (20%). If parents were rated as greater than 1 but less than or equal to 1.2, twins were placed in group 2 (25.1%). Twins with parents rated as greater than 1.2 but less than 1.5 were put into group 3 (20.5%), greater than or equal to 1.5 but less than 1.7 were placed in group 4 (14.4%), and greater than or equal to 1.7 (1.7-3.6, least sensitive) were categorized under group 5 (20%). The resulting group variable for parental sensitivity was normally distributed and used for analyses. Descriptives of all of the variables used in the current study can be seen in Table 5, and bivariate correlations between all variables from the original sample can be seen in Table 6.

Prior to analysis, potential sex effects on internalizing behavior, externalizing behavior, and parental sensitivity were explored. A one-way MANOVA revealed no sex differences on internalizing or externalizing behavior within the sample, Wilks' $\lambda = .930$, $F(2, 51) = 1.93$, $p = .156$. An independent samples *t*-test also revealed no sex differences on parental sensitivity, $t(52) = -.27$, $p = .787$. Therefore, sex was not included in any of the regressions for hypotheses 1 and 2.

Main Hypotheses

Hypothesis 1

Hypothesis 1 stated that children with more difficult temperament and who experience more daycare would be rated as having more behavior problems by parents. More specifically, it was hypothesized that children rated as more temperamentally shy and who experience more daycare would be rated as exhibiting more internalizing problems, whereas children rated as

more temperamentally active and impulsive and who experience more daycare would be rated as exhibiting more externalizing problems. These sub-hypotheses were tested via two separate linear regression models. For the first, shyness and number of months of daycare experience were included in the first block as independent variables to predict internalizing problems on the CBCL. Shyness and daycare months were both mean-centered. For the second block, an interaction term was created by multiplying shyness and number of months of daycare experience. The centered versions of these variables were used to avoid multicollinearity in this and all subsequent interactions (Aiken & West, 1991). Results indicated that neither shyness, $t(56) = 1.83$, $p = .072$, nor daycare, $t(56) = -.66$, $p = .510$, was predictive of internalizing problems. Moreover, the interaction between shyness and total months of daycare also did not predict internalizing problems, $t(56) = 1.36$, $p = .179$, thus rejecting hypothesis 1a (see Table 7).

For the second part of hypothesis 1, energy level (activity level/impulsivity/high intensity) and number of months of daycare experience (both centered) were included as independent variables in the first step to predict externalizing behavior on the CBCL. As was the case with hypothesis 1a, an interaction term was created by multiplying these variables together and was added in the second step. Neither energy level, $t(56) = 1.94$, $p = .057$, nor daycare, $t(56) = .00$, $p = 1.0$, was predictive of externalizing problems. However, their interaction was significantly predictive of externalizing problems, $t(56) = -2.11$, $p = .040$ (see Table 8). However, contrary to hypothesis 1b, highly energetic children with the most daycare experience did not exhibit the most externalizing behaviors. Rather, highly energetic children with little to no daycare experience exhibited significantly more externalizing behaviors when compared to highly energetic children who only experienced some daycare. Highly energetic children who experienced high amounts of daycare did not show a consistent pattern of externalizing behavior,

with some rated as exhibiting high amounts and others as exhibiting low amounts, and thus did not differ on externalizing from these other groups. Lastly, children who were not highly energetic did not differ on externalizing based on daycare experience (see Figure 1).

Hypothesis 1 Post-hoc. For hypothesis 1, the two *post-hoc* temperament composite variables (depressed/anxious and reticence) were assessed in relation with daycare on behavior problems via one linear regression analysis. The first block included the two temperament composites and total months of daycare (all mean-centered). Results revealed that depressed/anxious (sadness, reactivity reversed, fear, discomfort) was significantly predictive of internalizing problems, $t(56) = 2.60$, $p = .012$. However, reticence (shyness, impulsivity reversed), $t(56) = .38$, $p = .702$, and daycare months, $t(56) = -.80$, $p = .430$, were not predictive of internalizing problems. The interaction terms were added one at a time due to low power. In the second block, the interaction between the centered versions of depressed/anxious and daycare was added. Then, this was removed and the other interaction between reticence and daycare was added. The interaction between depressed/anxious and daycare months was not significantly predictive of internalizing problems, $t(56) = .63$, $p = .530$. The interaction between reticence and daycare months also was not significant, $t(56) = 1.90$, $p = .063$. Results of both regressions can be seen in Table 9.

The relationships between the 2 CBQ factors, Negative Affect and Effortful Control, and behavior problems also were examined via linear regression analysis. Two analyses were run (one predicting to internalizing behavior, one predicting to externalizing), all of which included both factors and months of daycare in the first block (all mean-centered). The interaction between the centered versions of Negative Affect and daycare was added in step two of both analyses, and then removed and replaced with the interaction between Effortful Control and

daycare. Negative Affect was significantly predictive of internalizing behavior, $t(56) = 3.19$, $p = .002$; however, Effortful Control, $t(56) = .76$, $p = .450$, and daycare months, $t(56) = -.81$, $p = .421$, were not (see Table 10). The interactions between Negative Affect and daycare, $t(56) = .21$, $p = .836$, and Effortful Control and daycare, $t(56) = 1.58$, $p = .120$, also were not significantly predictive of internalizing behavior. Negative Affect and Effortful Control also were explored in relation to externalizing behaviors (see Table 11). Neither Negative Affect, $t(56) = .95$, $p = .344$, Effortful Control, $t(56) = -.28$, $p = .779$, nor daycare, $t(56) = -.13$, $p = .895$, were predictive of externalizing problems. Similarly, the interaction between Negative Affect and daycare, $t(56) = 47$, $p = .638$, and between Effortful Control and daycare, $t(56) = 1.90$, $p = .063$, both were non-significant.

Hypothesis 2

Hypothesis 2 stated that children with greater risk from either difficult temperament or increased daycare experience would have less sensitive parents during parent-child interactions. More specifically, two main effects and one interaction were tested. First, it was hypothesized that children with more difficult temperament, as observed via shyness or high activity and impulsivity, would have less sensitive parents. Second, it was hypothesized that children who experience more daycare would also have less sensitive parents. Lastly, an interaction was expected to emerge, with children who had both a difficult temperament and more daycare experience experiencing the least sensitive parents during parent-child interactions. These hypotheses were tested through linear regression analysis.

Shyness, energy level, and number of months of daycare experience (all mean-centered) were entered in step 1 in order to test the main effects of these variables on parental sensitivity.

However, a regression with four predictors lacks the power to detect a large effect (three participants short), so separate regressions for each variable were run. Results of both regressions (shyness and energy level) were comparable to the combined regression, so the results from the combined regression are presented here. The second block included the interaction terms to predict to parental sensitivity. First, the interaction between the centered versions of shyness and daycare was added, and second, this was replaced with the interaction between energy level and daycare. Results (see Table 12) indicated that shyness, $t(54) = -1.47$, $p = .147$, energy level, $t(54) = 1.03$, $p = .310$, and daycare, $t(54) = .41$, $p = .687$, did not significantly predict parental sensitivity, meaning that hypotheses 2a and 2b were rejected. Moreover, the interaction between energy level and daycare also was not significant, $t(54) = 1.60$, $p = .115$, meaning that hypothesis 2c was rejected for children who are highly active, impulsive, and intensely reactive. In contrast, the interaction between shyness and daycare was significant, $t(54) = -2.11$, $p = .040$. However, contrary to hypothesis 2c, highly shy children who experienced more daycare did not have parents who were less sensitive. In fact, the opposite seems to be true. Children rated highly on shyness and who experienced the most daycare had parents who were significantly more sensitive when compared to children who were rated low on shyness and experienced the most daycare. There were no differences in parental sensitivity for children who experienced less daycare, regardless of their level of shyness (see Figure 2).

Hypothesis 2 Post-hoc. The two internalizing temperament composite variables that were created and assessed *post-hoc* for hypothesis 1 also were assessed in relation to the outcome variable for hypothesis 2. Both variables were mean-centered and included in the first block of the regression analysis, with interactions between them and daycare created and separately added to the second block. Results indicated (see Table 13) that depressed/anxious

temperament, $t(54) = -.17$, $p = .869$, and daycare, $t(54) = .40$, $p = .688$, were not significantly predictive of parental sensitivity. However, reticence was significant, $t(54) = -2.09$, $p = .042$. Interestingly, the interaction between depressed/anxious and daycare, $t(54) = 2.90$, $p = .005$, and the interaction between reticence and daycare, $t(54) = -2.21$, $p = .031$, were both significantly predictive of parental sensitivity; however, examinations of each graph revealed drastically different results. Children who experienced the most daycare and high levels of depressed/anxious temperament had parents who were significantly less sensitive when compared to children with high levels of depressed/anxious temperament who experienced less daycare. Moreover, those children rated highest on depressed/anxious temperament and who experienced the most daycare also had the least sensitive parents when compared to children with the most daycare but who had less depressed/anxious temperament (see Figure 3). When examining reticence, for children with little daycare experience, levels of reticence did not seem to affect parental sensitivity. However, children rated highly on reticence and who experienced the most daycare had the *most* sensitive parents when compared to children who experienced this amount of daycare but were rated lower on reticence (see Figure 4).

The relationships between the 2 CBQ factors and parental sensitivity also were explored via regression analysis. Results are shown in Table 14 and indicated that Negative Affect, $t(54) = -1.20$, $p = .238$, Effortful Control, $t(54) = .77$, $p = .442$, and daycare, $t(54) = .23$, $p = .822$, all were not predictive of parental sensitivity. Although the interaction between Effortful Control and daycare was not significant, $t(54) = .00$, $p = .998$, the interaction between Negative Affect and daycare was significantly predictive of parental sensitivity, $t(54) = 2.02$, $p = .048$. Children with high amounts of Negative Affect and who experienced the most daycare had parents who were significantly less sensitive than parents of children with high levels of Negative Affect but

lower amounts of daycare. These children also had the least sensitive parents when compared to all children rated lower on Negative Affect, regardless of their levels of daycare experience. There was no difference in parental sensitivity among children rated lower on Negative Affect across all levels of daycare experience (see Figure 5).

Hypothesis 3

Hypothesis 3 only examined MZ twins in order to control for shared genetics. In other words, since MZ twins share 100% of their genes, this hypothesis was able to examine aspects of temperament that are influenced by non-genetic factors when exploring possible reasons why parents show differential amounts of sensitivity to their children during an interaction. This hypothesis stated that twin pairs whose parents were concordant on sensitivity (showed the same amount to both twins) would be more similar temperamentally, whereas twin pairs whose parents were discordant on sensitivity (showed different amounts of sensitivity to each twin) would be more temperamentally different from one another. In order to test this hypothesis, two groups of twin pairs were created based on parental sensitivity. These groups were created from the five parental sensitivity groups (1-5) that were created for hypothesis 2. One group was characterized by parents who were concordant on sensitivity to both twins (both twins were in the same sensitivity group), whereas the other group was made up of twin pairs who experienced differential amounts of sensitivity (twins were in different sensitivity groups). Six temperament difference variables were then created for every twin pair by finding the difference in the temperament variables (shyness, energy level, depressed/anxious, reticence, Negative Affect, Effortful Control) between Twin 1 and Twin 2. Unfortunately, the sensitivity groups that were created were not equal (4 pairs in the same sensitivity group, 15 pairs in the different sensitivity group). For this reason, twins were regrouped in a different way by conceptualizing "same

sensitivity" as being within 1 group of one another (i.e., twin 1 with a score of "1" and twin 2 with a score of "2" would be categorized as same sensitivity). However, this resulted in a similarly unequal split between groups (14 and 5). Therefore, the use of a *t*-test was no longer appropriate to analyze hypothesis 3.

Instead, a sensitivity difference variable was created between Twin 1 and Twin 2 of each pair by subtracting Twin 2's original score (1-5) from Twin 1's score. Then, bivariate correlations were run between this variable and the six temperament difference variables. Twin 2 was always subtracted from Twin 1, both for the temperament difference and sensitivity difference variable, in order to make sure that the direction of effect was the same across all correlations. Results (see Table 15) indicated that the difference between Twin 1 and Twin 2 on Effortful Control was significantly correlated with the difference in sensitivity shown to Twin 1 versus Twin 2, $r(17) = .73$, $p < .01$. More specifically, when twins were more different on Effortful Control when compared to one another, the twin with higher levels of Effortful Control received less sensitivity from their parents than their co-twin. However, none of the other temperament difference variables were significantly correlated with the sensitivity difference variable. Thus, hypothesis 3 was partially supported.

Hypothesis 4

Hypothesis 4 included all twin pairs and stated that there would be a significant correlation between time spent in daycare and temperamental dissimilarity between co-twins. In other words, it was expected that more time spent in daycare would be related to twin pairs being less alike, with daycare acting as a source of *nonshared* environment. Because the analyses looked at temperament difference scores between twins, it was expected that a positive

correlation would emerge between more time spent in daycare and temperamental difference scores (hypothesis 4a). In addition, the correlation between daycare experience and temperamental dissimilarity was expected to be significantly stronger for DZ pairs than for MZ pairs (hypothesis 4b).

For Hypothesis 4a, a correlation was run between number of months of daycare experience (which is the same for co-twins) and the absolute value of the six temperament difference variables for all twin pairs. Among all twin pairs, none of the six correlations were statistically significant. Therefore, hypothesis 4a was not supported (see Table 16).

To test Hypothesis 4b, the same correlations were run for MZ and DZ twins separately (see Table 17). Once the 12 correlations (six for MZ and six for DZ) were computed, all MZ and DZ correlations for each temperament variable were compared with one another using a Fisher's r→ z transformation (Fisher, 1915) to test for significant differences. Results indicated that for MZ pairs, none of the six correlations were significant. In contrast, in addition to all six correlations for DZ pairs being in the hypothesized direction (positive), the correlation between number of months of daycare and the difference in depressed/anxious temperament was significant, $r(44) = .33$, $p = .024$. The correlation between number of months of daycare and the difference in Negative Affect also was significant, $r(44) = .35$, $p = .016$. Fisher's r→z transformations indicated that the two significant DZ correlations (depressed/anxious and Negative Affect) were significantly different from the corresponding MZ correlations using a one-tailed test, thus supporting hypothesis 4b for these temperament variables.

CHAPTER 5

DISCUSSION

The present study had two major goals. The first was to explore the potential effects that time spent in daycare may have on children with more difficult temperaments, both on parent-rated behavior problems as well as on sensitivity shown to them by their parents during an interaction. The second goal was to utilize twin methodology in order to further explore parental sensitivity and time spent in daycare. More specifically, sensitivity shown to MZ twin pairs was examined in order to investigate whether or not temperamental differences between the twins had any influence on the amount of sensitivity shown to them. By only examining MZ twins, any potential genetic influences on sensitivity were able to be controlled for. In addition, time spent in daycare for MZ and DZ twin pairs was examined in order to see whether or not it had an impact on the temperamental dissimilarity between co-twins. More specifically, this analysis allowed exploration into whether daycare acted more as a *shared* environment or *nonshared* environment for twins, as well as whether or not MZ and DZ twins' genetic makeup was related to their environment in any way (testing rGE).

Results supported the hypotheses that there are indeed some interactive relationships occurring between child temperament and daycare on problem behaviors and parental sensitivity, as well as temperamental effects related to parental sensitivity and time spent in daycare. However, before further explanation of these effects, it must be noted that the study's small sample size is a major limitation to this interpretation. Moreover, when exploring the interactions, splitting variables into groups in order to try to find the effect resulted in some very small groups for a few of the variables. Thus, although the effects found are interesting and worth examining, they should be replicated in order to confirm their validity.

Although there was not an interactive relationship between shyness and daycare on internalizing behaviors, an interactive relationship did exist between energy level and daycare on externalizing behaviors. However, the relationship that emerged was not as hypothesized. More specifically, children rated as highly active, intensely reactive, and highly impulsive and who experienced the *least* amount of daycare exhibited the most externalizing behaviors. The amount of daycare did not seem to matter in predicting externalizing behavior for children who were not rated highly on energy level. Therefore, it seems that the most active children may benefit from time spent in daycare, as opposed to being negatively affected by it, as was hypothesized. Perhaps these children need the daycare environment to be active and interact with other children, and when they are able to do so, they have less energy at home and as a result are rated as less externalizing by their parents. On the other hand, perhaps highly active children who are not in daycare are more likely to be rated as externalizing simply because they are spending more time with their parents, who are rating them. However, it also could be the case that the current study simply missed the true effect of daycare on children with this form of difficult temperament. Schipper, Tavecchio, van Ijzendoorn, and Van Zeijl (2004) also did not find a relationship between difficult temperament and externalizing behaviors for children with increased daycare experience, and noted that this could be because their measure of difficult temperament did not include an item assessing resistance to control, an item that Rothbart and Bates (1998) found to be an important link to externalizing. The current study's conceptualization of this form of difficult temperament also did not include an item related to resistance to control, instead focusing on activity level, which may explain the lack of relationship with externalizing behaviors. Overall, in absence of a problem with this study's

measurement of this temperamental style, it seems that highly active children may benefit from the opportunity to interact with other children and expend energy in the daycare setting.

Thus, of the two hypothesized "difficult" temperaments, the more active form (energy level) may interact with daycare to influence child behaviors, whereas the more inhibited form (shyness) may not. This was further supported by the fact that depressed/anxious temperament and reticence, both characterized as more inhibited and thought to represent temperaments likely to be related to internalizing behaviors, also did not interact with daycare to predict child behavior. Degnan and Fox (2007) reviewed the literature and found that daycare has been linked with less inhibition in infants and toddlers in some studies; however, other studies have not found this link. Other studies cited in this paper have illustrated the negative implications of daycare on children who are anxious (Coplan, Findlay, & Schneider, 2010). Therefore, Degnan and Fox explain that more work is needed on this effect, as its complexity may be due to specific environmental factors that vary across daycare that are interacting with child temperament. The current study did not assess the potential temperamental effects of daycare (e.g. daycare causing more or less inhibition in children); however, it did examine internalizing as an outcome, for which no link was found with time spent in daycare.

Daycare and Temperament Effects on Parental Sensitivity

Parental sensitivity seemed to be affected by the interaction between child temperament and time spent in daycare. However, time spent in daycare on its own was never predictive of parental sensitivity shown to their children, failing to support prior research that has shown that more time spent in daycare has the potential to negatively affect parental sensitivity (NICHD,

1999). This is consistent with the major premise of this study; daycare's effects rely on other factors, such as child temperament, in their effects on child outcomes.

Although neither of the hypothesized temperaments were predictive of parental sensitivity on their own, the interaction between shyness and time spent in daycare was significantly predictive. However, the effect that emerged was in contrast to what was hypothesized. Rather than children rated as the most shy and who experienced the most daycare having the least sensitive parents, the opposite seems to be true. For children rated highly on shyness, those who experienced the most daycare had parents who were significantly *more* sensitive than children who experienced less daycare. Children who experienced less daycare, regardless of their level of shyness, did not differ on parental sensitivity. Therefore, it seems that, at least in terms of received sensitivity from their parents, more daycare may be good for highly shy children. This result supports the idea that shy children whose parents provide them with experiences in which they can interact with other children become less shy over time (Kagan & Snidman, 2004), and can be interpreted in two ways. First, in line with Kagan and Snidman's (2004) findings, increased social stimulation from the daycare setting may improve a child's social functioning by providing children with skills to adjust in stressful social situations (Copeland, Findlay, & Schneider, 2010). Consequently, this may improve their day-to-day functioning, resulting in more sensitive reactions from their parents. It would be both interesting and informative to see if parental sensitivity goes up over time as children rated as shy continue to experience more daycare. However, despite this environment potentially providing exposure to social strategies to shy children, it is unclear whether specific caregiver factors or increased peer interactions are more responsible for these positive effects on shy children (Degnan & Fox, 2007). In contrast, this result may suggest that more sensitive parents are more aware of their

child's shyness and more likely to place them in daycare in order to expose them to a socially interactive environment in which they can learn socially adaptive behavior (Degnan & Fox, 2007).

Examination of the *post-hoc* variables, all considered as more inhibited forms of temperament, also revealed significant effects on parental sensitivity. Therefore, it seems that more active forms of difficult temperament may matter most when examining its relationship with daycare on behavior problems, but the relationship between more inhibited forms of difficult temperament and daycare may be crucial when examining parental sensitivity. Results of the *post-hoc* variables are discussed below.

Three *post-hoc* temperament by daycare interactions emerged. For example, children rated highly on depressed/anxious temperament and who experienced the most daycare had the least sensitive parents when compared to children rated lower on depressed/anxious temperament and high amounts of daycare. These children also had the least sensitive parents when compared to children with less daycare experience but who also had high levels of depressed/anxious temperament. Perhaps more sensitive parents are aware of their child's temperament and think that keeping them home may be best, as opposed to sensitive parents who placed their shy children in daycare for increased social stimulation, as discussed previously. Nevertheless, although not a hypothesized temperament variable, this pattern reflects more of what was hypothesized: children with more difficult temperament (in this case, more depressed/anxious) and high amounts of daycare have less sensitive parents. Therefore, it may be the case that daycare is adversely affecting these children, and if this effect is evidenced by parental sensitivity, it may be because distress experienced at daycare causes these children to be less easy to interact with. More specifically, it seems that something about the daycare environment

may affect children who exhibit negative affect in response to stimulation, are fearful, and take longer to recover from peak distress or arousal. Perhaps the daycare environment acts as an overwhelming experience for these children, resulting in a negative behavioral reaction that consequently affects their interactions with their parents. In contrast with children who are shy, these children have temperamental traits that seem to prevent them from experiencing daycare as adaptive. This supports research that has found that children who are easily frustrated and highly distressed in response to novelty (Crockenberg & Leerkes, 2005) and are fearful (Watamura, 2003) are more distressed by time spent in daycare.

In contrast with depressed/anxious temperament, children rated highly on reticence and who experienced the most daycare had the *most* sensitive parents when compared to children who experienced the most daycare but rated lower on reticence. Children with less daycare experience, regardless of level of reticence, did not differ on parental sensitivity. Therefore, it seems that something about the daycare environment may act as a positive experience for children who are shy and slow to respond to stimuli. Perhaps, as opposed to children with high amounts of depressed/anxious temperament who may be overwhelmed by the daycare environment, these children experience daycare as more of a "corrective" experience. Instead of reacting with fear and negative affect, perhaps although initially shy and slow to respond to the daycare environment, over time these children become more able to interact with other children and begin to benefit from the social stimulation that daycare provides. As mentioned in the discussion of shy children, this result supports the notion that increased social stimulation may improve a child's social functioning (Degnan & Fox, 2007), thus positively affecting their interaction with their parents. This result makes sense, considering shyness is included in the reticence temperament variable. Nevertheless, this result suggests that children rated as shy *and*

who are additionally not impulsive may benefit from more daycare. However, as also mentioned previously, it also could be the case that more sensitive parents are more likely to place their shy children in daycare in order to try to give their children adaptive environments in which they can learn to interact more positively with peers.

The last temperament variable that had an interactive relationship with daycare on parental sensitivity was Negative Affect. This pattern was more consistent with the relationship between depressed/anxious temperament and daycare: children rated highly on negative affect and who experienced the most daycare had the least sensitive parents overall. Again, although not a hypothesized temperament variable, this represents more of what was hypothesized: children with more difficult temperaments and who spend more time in daycare would have the least sensitive parents. As was the case with depressed/anxious temperament, perhaps children who are sad, fearful, angry, easily made uncomfortable and less soothable after distress are easily distressed by the daycare environment and react poorly to it, which may negatively impact their interactions with their parents. Again, as was the case with depressed/anxious temperament, this supports research that has found that children with more difficult temperaments are adversely affected by time spent in daycare (Crockenberg & Leerkes, 2005; Watamura, 2003). However, as first noted, sample size is especially important to note for this effect, as only two children were in the highest third of daycare experience and over 1 SD on Negative Affect, meaning that this effect is driven by a very small sample size. Nevertheless, it is an interesting finding that warrants further examination.

In sum, these results suggest that in terms of behavior problems, children who are more active, impulsive, and intensely reactive may benefit from time spent in daycare by exhibiting fewer externalizing behaviors. It also seems that children who are shy and not impulsive may

benefit from daycare in that parents may show them more sensitivity, perhaps because children are learning more adaptive ways of communicating that make them easier to interact with. In contrast, children who are characterized by more depressed/anxious temperamental characteristics (sad, fearful, angry, easily made uncomfortable and less soothable after distress) may be adversely affected by time spent in daycare, as evidenced by less received parental sensitivity during the parent-child interaction task.

Differential Parenting

The other major goal of the present study was to utilize the twin design to further explore some of the constructs examined in this study. The difference between MZ co-twins on Effortful Control was significantly positively correlated with the amount of sensitivity shown to the twins. In other words, differential sensitivity shown by parents may arise because co-twins are exhibiting differential levels of Effortful Control. Specifically, twins who had high levels of Effortful Control had parents who were in higher sensitivity groups, meaning that the twin received *less* sensitivity than twins who were lower on Effortful Control. Therefore, parents may be responding differently to each twin as a result of the differing levels of Effortful Control shown by each twin. However, the opposite also may be true, as children may be responding differently as a result of parent sensitivity. Nevertheless, since only MZ twins were examined, genes were able to be held constant, meaning that it cannot be the case that shared genes are driving the correlation.

Twins who scored highly on this temperamental composite were those who are able to focus their attention, inhibit inappropriate responses, notice environmental stimuli low in intensity, and enjoy the situations involving the low intensity stimuli. Therefore, perhaps these

twins were exhibiting self-stimulating behavior that kept them occupied during a parent-child interaction, resulting in less drive for parental attention. It could be the case that these children were not receiving much sensitivity from their parents because they were not exhibiting many behaviors that would evoke it. On the other hand, this result also could mean that level of Effortful Control exhibited by twins is shaped by parental sensitivity, rather than child behavior only affecting parental behavior. This would be supported by the transactional model of development (Sameroff, 2009), which explains that both child and environment (in this case, parents) are constantly affecting one another in a dynamic fashion. In this interpretation, lack of parental sensitivity could have potentially influenced children to act in more ways that are consistent with high levels of Effortful Control. Perhaps lack of parental sensitivity influenced children to play more on their own during an interaction. However, this result was not seen for any of the other five remaining temperament variables. It could be the case that these other temperament traits and parental sensitivity are not related. Beyond shared genes, there may be other factors that can explain why some parents offer the same amounts of sensitivity to their twins and others do not.

Gene-Environment Correlations

The current study also explored the potential effect of the daycare environment on temperamental dissimilarity between MZ and DZ co-twins. For all twin pairs combined, more time in daycare did not correlate with twins being more similar or dissimilar temperamentally. However, examination of the difference between MZ and DZ pairs provided some interesting results. None of the MZ pairs' temperament difference scores were significantly correlated with time spent in daycare, meaning that more time spent in daycare did not cause MZ pairs to be more similar or dissimilar temperamentally, despite their identical genetic makeup. In contrast,

two correlations for DZ pairs were significant. Specifically, the differences between DZ twins on depressed/anxious temperament and Negative Affect were significantly correlated with time spent in daycare, suggesting that DZ twins who experienced high amounts of daycare were more likely to become more dissimilar on these temperament variables. Moreover, the results also indicated that these two correlations were significantly different from these temperament correlations for MZ pairs. These findings argue for daycare acting as a nonshared environment for DZ twins, even though both twins experience daycare together. It could be the case that twins experience daycare in different ways, meaning that they do different things and interact with different people while there. This environment may be more varied than the one they experience together at home, perhaps leading them to become more dissimilar temperamentally.

This finding partially supports a gene-environment correlation (rGE), or in other words, a genetic influence on DZ twins' reactions to the daycare setting. At daycare, two DZ twins may experience less similar daycare environments than MZ twins because DZ twins are more different from one another than MZ twins. As a result, if twins' genes are correlated with the daycare environment, DZ twins are thus more likely to experience daycare differently from their co-twin. Since MZ twins did not become more different temperamentally with more daycare, the fact that DZ twin did suggests that children's genetic makeup may be influencing how they experience daycare (their genes and environment are correlated). In other words, two DZ co-twins (who share only 50% of their genes) are more likely to experience daycare differently from one another compared to MZ co-twins, and are thus more likely to differ temperamentally from their co-twin to the degree that daycare affects temperament. By utilizing the twin methodology, the current study was able to provide evidence for rGE in the daycare setting.

Strengths

The current study addresses gaps in the current literature in a few ways. First, this study is unique in that it connects three different constructs -- daycare, child temperament, and parent-child interactions -- that are most often only examined in pairs in the literature. In other words, little to no research examines all three constructs simultaneously. The current study was able to test the effects of these variables in pairs in order to examine the effects that have already been established in the literature as well as examine all three constructs together. Therefore, a fuller picture that includes a child's experiences at home and at daycare was able to be examined.

Secondly, this study answers the call of Philips et al. (2011) who argue that the literature needs to take individual temperamental differences into account when exploring the effects of daycare. The authors argue that studies need to better explore what *specific* aspects of temperament are involved in determining how a child reacts to the daycare setting. This study did not simply explore "difficult" temperament in relation to daycare and parent-child interactions; rather, it split temperament up into several distinct patterns, all thought to measure different aspects of a child's temperament that may be interacting with the daycare setting and their parent's behavior during an interaction.

An additional strength of this study is that it links daycare experience and some aspects of "difficult" temperament to *fewer* problems, perhaps reducing the stigma of the "difficult" temperament label and instead emphasizing more of a "goodness-of-fit" explanation of child temperament. Because the current study examined a variety of specific temperamental characteristics, children were distinguished by more specialized temperament groups, rather than simply aggregating them all together as "difficult." Although the term is still used intermittently throughout this paper, the results clearly indicate that *specific* aspects of temperament are

interacting with daycare to influence behavior problems and parental sensitivity, and in some cases, these traits are interacting with daycare in a positive way. This conceptualization supports Rothbart's (1982) argument against the "difficult" temperament label, as certain behaviors may be appropriate in some situations and not others and there are costs and benefits to having any temperamental trait, not just those labeled as "difficult." Lastly, this study utilized the twin method in order to examine genetic and environmental influences on how child temperament may affect parental sensitivity and be affected by the daycare setting. Few studies have used the twin method to explore these types of effects.

Limitations

There also are several limitations to this study. First, as previously mentioned, the study's sample size is a limitation to the interpretation of these results. More specifically, due to the twin design of the study, only one twin from each pair was included in the analyses of hypothesis 1 and 2, splitting the available sample in half. Further, the sample size also was lessened due to limited CBQ data when compared to the other variables used in the study. The current sample size for hypothesis 1 was only adequate to detect large effect sizes, whereas the sample size for hypothesis 2 was two children away from having the power to detect a large effect. Additionally, when interpreting the five significant interactions from hypotheses 1 and 2, splitting variables into groups based on frequency tables and standard deviations resulted in very small groups in some cases. This also limits the interpretability of the results.

The parental sensitivity variable that is used for hypotheses 2 and 3 also has some limitations. Parental sensitivity shows very little variability in this study, which is why it had to be transformed in order to try to vary the distribution. Although there were effects found with parental sensitivity in this study, it must be noted that they were found in a highly functioning,

highly sensitive sample. Moreover, lack of variability may have hindered the current study's ability to truly capture effects, which could be due to the fact that this variable comes from only ten minutes of observation of a parent-child interaction in the lab. Because parents know that they are being watched, they may be more likely to act in ways that present themselves in a more favorable light, thus perhaps explaining the lack of a more normal distribution of the parental sensitivity variable. This also negatively impacts the current study's ability to generalize these results to other populations. Additionally, sensitivity in this context could be argued to represent a more state-like rather than trait-like behavior; however, it also could be argued that parents generally have a certain level of sensitivity with their children. Although variability most certainly exists for each parent based on situational factors (e.g. parent having a bad day, preoccupied with other tasks), it seems that most parents can be generally classified as being either mostly sensitive or mostly insensitive to their child's needs. However, without a more in-depth look at parent-child interactions, it is impossible to truly distinguish whether parental sensitivity shown in the lab is more indicative of the situation or the parent's true tendencies.

Additionally, the interactions used in the current study were all triadic (between parent and both twins), rather than dyadic (between parent and one twin). If a researcher wanted to assess the direct relationship between one parent and one child only, the presence of another sibling could be problematic. More specifically, a parent's reaction to the other sibling may positively or negatively influence how they act toward the first child, regardless of how that child is acting. However, it could equally be argued that triadic interactions are more representative of the true environment that a parent and child engage in normally, as it is often difficult for a parent to have one-on-one time with one twin without the other present, especially at this young age. Therefore, these triadic interactions may actually be more accurate in depicting the parent-

child relationship. Nevertheless, future studies should, if possible, look at parental sensitivity during both types of interactions, as parent behavior may differ between them.

This study did not examine daycare quality, mostly due to a poor indicator of quality in the data as well as limited variability in what was available. Although daycare quality has been mostly linked with academic and cognitive functioning (Jacob, 2009), which was not the focus of the study, it has been found that difficult temperament can moderate the socioemotional effects of quality of daycare. For example, Belsky and Pluess (2011) found that children with difficult temperament exhibited more behavior problems when in low quality daycare; however, children with difficult temperament showed fewer problems with high quality care when compared to those with easy temperaments. Therefore, when taking temperament into account, daycare quality may also matter when predicting behavioral reactions to the daycare setting. Future research should examine daycare quantity and quality simultaneously in order to fully explore the relationship that temperament may have with both.

Future Directions

Although this study sheds some light on what effects daycare can have on children with varying temperaments, less is known about *why* these effects are occurring. In other words, what is actually happening in the daycare setting for children of varying temperaments? What about the environment is interacting with temperament to drive these interactive effects of daycare and temperament on behaviors and parental sensitivity? As Phillips et al. (2011) point out, one of the goals of future daycare research should be to focus more on actual daycare observation in order to try to make sense of these questions. Additionally, the authors suggest a few other directions for future research that all apply here. First, there need to be additional longitudinal studies in order to assess how children with various temperaments change over time with more experience

with daycare. This could also be useful in assessing how parent sensitivity changes over time as well, as mentioned in the discussion of whether or not parental sensitivity goes up over time as shy children experience more daycare, for example. Relatedly, future studies should attempt to observe parent-child interactions in much more depth in order to gain a better picture of how daycare may be affecting parental sensitivity. Next, the authors suggest that future research continue to link temperament and cortisol levels in their observations of daycare's effects in order to assess how these two mechanisms may interact to affect a child's reaction to the daycare setting. Lastly, other environmental influences, such as poverty and poor education, should be considered in line with daycare research. As mentioned in this paper, parents don't always have the resources to choose specific daycares for their children, and this could have a large impact on how their children react to the daycare setting that they are placed in.

Clinical Implications

The effects of daycare remain an interesting and relevant topic to both parents and psychologists, as the percentage of children attending center-based daycare remains large (Laughlin, 2010). Therefore, any study examining these effects should be applicable to a large portion of the population. Moreover, as the literature continues to move towards a more individualized approach to the effects of daycare, as argued by Philips et al. (2011), parents can begin to understand the *specific* effects that daycare may have on their child, dependent on their child's temperamental style. For example, studies have linked increased time in daycare with more distress and behavior problems for children who are easily frustrated and highly reactive (Crockenberg & Leerkes, 2005), socially fearful (Watamura et al., 2003), and anxious and withdrawn (Tout et al., 1998). Although the current study did not find support for a temperament x daycare interaction on behavior problems in which daycare causes more behavior

problems, it did find that children with certain temperaments who experienced high amounts of daycare had less sensitive parents. For example, the current study found that children with high levels of negative affect, fearfulness, and longer recoveries from distress, as well as children who are often sad, fearful, angry, and easily made uncomfortable, were more likely to experience less sensitivity from their parents when experiencing high amounts of daycare, thus suggesting a link between their reactions to the daycare setting and their interactions with their parents.

Therefore, this literature can make parents, as well as daycare workers, aware of the potential negative effects of daycare on their children dependent on their temperament. Although not always feasible, parents with children who are more depressed/anxious or high on negative affect may want to explore other child care options with this knowledge. For example, Coplan, Findlay, and Schneider (2010) found that highly anxious children placed in home-based care were significantly less anxious 2 years later when compared to highly anxious children placed in center-based care. In other words, alternate forms of child care may be beneficial for children who are anxious.

On the other hand, the current study also suggests some positive effects of daycare. For example, highly active children may benefit from increased daycare in the form of fewer behavior problems, and highly shy children may benefit from more daycare in the form of increased parental sensitivity. So, not only can these findings inform parents as to what daycare settings to potentially avoid based on their child's temperament, it may also lead them to actively choosing a center-based daycare as well. However, as previously mentioned, parents often do not have much choice when it comes to childcare, sometimes only having one option, regardless of their child's temperament. Therefore, at the very least, this literature can make parents aware of the potential problems that may occur up front, hopefully allowing them to be better able and

ready to handle their child's reactions to daycare when they occur. Additionally, these findings can inform daycare workers as well, whose knowledge of each child's specific temperament can shape how they engage and interact with each child in the daycare setting.

Conclusion

The current study explored the effect that time spent in daycare may have on children with more difficult temperaments, both in terms of parent-rated behavior problems and parental sensitivity. Children rated as highly active, intensely reactive, and highly impulsive were more likely to be rated as externalizing when they experienced less daycare. Additionally, four temperament variables showed interactive relationships with daycare when predicting parental sensitivity. Children rated as shy and children rated as shy and also not impulsive who experienced more daycare had more sensitive parents. In contrast, children who experienced high amounts of daycare and high levels of negative affect, fearfulness, and longer recoveries from peak distress, as well as children rated as sad, fearful, angry, and easily made uncomfortable and less soothable after distress had less sensitive parents. This study also further explored parental sensitivity and daycare by utilizing the twin methodology of the sample. When holding genes constant by examining only MZ twins, differences in effortful control between co-twins emerged as a function of differential parental sensitivity. However, this relationship was not seen with any other temperament variable. Additionally, there were interesting differences between MZ and DZ twins when examining time spent in daycare. DZ co-twins were more likely to be different on depressed/anxious temperament and negative affect when experiencing high amounts of daycare. Therefore, a possible gene-environment correlation was evident between these two temperamental styles and time spent in daycare.

In sum, this study demonstrated that there do seem to be effects of daycare on child behavior problems and parental sensitivity; however, child temperament is an important moderating factor that cannot afford to be neglected in the daycare literature.

Table 1

Estimated Effect Sizes for Hypotheses 1-4

Hypothesis	Small effect	Medium effect	Large effect	Actual Sample
1	$f^2 = .02$ 863 participants ($F(3, 859) = 2.62$, $p = .05$)	$f^2 = .15$ 119 participants $F(3, 115) = 2.68$, $p = .05$)	$f^2 = .35$ 54 participants $F(3, 50) = 2.79$, $p = .05$)	58 children 28 males, 30 females
2	$f^2 = .02$ 934 participants ($F(3, 929) = 2.38$, $p = .05$)	$f^2 = .15$ 129 participants $F(4, 124) = 2.44$, $p = .05$)	$f^2 = .35$ 59 participants $F(4, 54) = 2.54$, $p = .05$)	56 children 28 males, 28 females
3	$r = 0.1$ 616 participants	$r = 0.3$ 67 participants	$r = 0.5$ 23 participants	19 MZ pairs 14 males, 24 females
4	$r = 0.1$ 616 participants	$r = 0.3$ 67 participants	$r = 0.5$ 23 participants	66 pairs (20 MZ, 46 DZ) 62 males, 70 females

Table 2

Family Information

Variable	Minimum	Maximum	Median
Mother's Education	2	5	4.0
Mother's Occupation	1	7	3.0
Father's Education	2	5	4.0
Father's Occupation	1	7	3.0
Income	4	12	12.0

Note: Rating scales: maternal/paternal education (1 = some high school to 7 = advanced training beyond college degree), maternal/paternal occupation (1 = unskilled labor to 7 = high level professional, family income (1 = less than $5,000 to 12 = greater than $55,000).

Table 3

Cronbach's Alphas for CBQ Factors

First-order factors	SITSS Sample	Rothbart's CBQ Sample
CBQ Activity	.75	.75
CBQ Anger	.83	.80
CBQ Approach	.55	.74
CBQ Attention	.76	.67
CBQ Discomfort	.69	.73
CBQ High Intensity	.74	.79
CBQ Impulsivity	.71	.74
CBQ Inhibitory Control	.60	.76
CBQ Low Intensity	.68	.64
CBQ Perceptual Sensitivity	.62	.64
CBQ Sadness	.58	.69
CBQ Shyness	.89	.92
SBQ Smiling	.71	.75
Second-order factors		
Extraversion (Surgency)	.72	
Negative Affect	.72	
Effortful Control	.64	

Table 4

Rotated Factor Loadings for Temperament Composite Variables – Hypothesis 1 & 2 Post-hoc

Variables	First factor	Second factor
CBQ Sadness	.80	.10
CBQ Reactivity	-.71	-.31
CBQ Discomfort	.70	-.12
CBQ Fear	.61	-.31
CBQ Shyness	.59	-.43
CBQ Activity	.02	.82
CBQ Impulsivity	-.23	.81
CBQ High Intensity	.06	.72

Table 5

Descriptives of All Study Variables

Variable	Minimum	Maximum	Mean	SD
CBQ Activity	2.43	7.0	5.19	.99
CBQ Anger	1.83	7.0	4.57	1.25
CBQ Attention	1.67	7.0	4.82	1.07
CBQ Discomfort	1.17	7.0	4.40	1.25
CBQ Fear	1.0	6.83	3.64	1.22
CBQ High Intensity	2.67	7.0	5.52	1.02
CBQ Impulsivity	2.0	7.0	4.59	1.12
CBQ Impulsivity Reversed	1.0	6.0	3.41	1.12
CBQ Inhibitory Control	2.0	6.83	4.61	.98
CBQ Low Intensity	3.38	7.0	6.03	.65
CBQ Low Intensity (Squared)	11.39	49	36.81	7.51
CBQ Perceptual Sensitivity	2.33	7.0	5.53	.88
CBQ Perceptual Sensitivity (Squared)	5.44	49	31.40	9.10
CBQ Reactivity	1.83	7.0	4.72	1.12
CBQ Reactivity Reversed	1.0	6.17	3.28	1.12
CBQ Shyness	1.0	7.0	3.88	1.51
CBQ Sadness	2.0	6.4	4.09	.88
Energy Level	8.13	21	15.30	2.59
Depressed/Anxious	7.5	22.83	15.40	3.11
Reticence	2.17	12.83	7.29	2.35
CBQ Negative Affect	10.67	29.05	19.97	3.92
CBQ Effortful Control	36.98	111.67	77.63	14.83
Total Out of Home Daycare	0	59	25.89	17.08
Total of Home Daycare (SQRT)	0	7.68	4.58	2.23
CBCL Internalizing sum	0	21	2.94	3.93
CBCL Internalizing sum (LN)	0	3.09	.99	.85
CBCL Externalizing sum	0	34	8.08	7.64
CBCL Externalizing sum (SQRT)	0	5.83	2.45	1.45
Parental sensitivity	1.0	3.60	1.40	.39
Parental Sensitivity groups (1-5)	1	5	3.02	1.45

Table 6

Bivariate Correlations between all Variables used for all Children in Original Sample

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1																	
2	.16	1																
3	-.22*	.25*	1															
4	-.16	-.55**	-.25**	1														
5	-.11	.24**	.35**	-.23*	1													
6	.54**	.20*	-.18	-.09	-.08	1												
7	.57**	-.08	-.10	.02	-.16	.45**	1											
8	-.00	.47**	.37**	-.39**	.29**	-.09	-.16	1										
9	-.26**	.18*	.27**	.17	.29**	-.19*	-.59**	.22*	1									
10	-.01	.74**	.66**	-.70**	.63**	-.01	-.15	.69**	.33**	1								
11	-.22*	-.23*	.15	.33*	.07	-.17	-.06	.03	-.11	-.10	1							
12	.85**	.10	-.20*	.09	-.15	.80	.83	-.11	-.43	-.08	-.18	1						
13	-.08	.53**	.73**	-.66**	.70**	-.10	.16	.69**	.34**	.96**	-.03	-.14	1					
14	-.44**	.16	.22*	-.12	.26**	.34**	-.85**	.22*	.92**	.28**	-.04	-.67**	.29**	1				
15	.06	.04	.01	-.13	.01	-.01	-.01	.01	.10	.06	-.04	.01	.06	.07	1			
16	.07	.21*	.12	-.36**	.08	-.07	-.11	.18*	.30**	.27**	-.02	-.05	.26**	.24**	-.06	1		
17	.28**	.23*	.05	-.26**	-.13	.14	.13	.03	-.02	.13	-.11	.22*	.07	-.08	.02	.61**	1	
18	.19*	-.14	-.00	.11	-.18	.17	.24**	-.21*	-.20*	-.18	.04	.24**	-.17	-.24**	.10	-.01	.20*	1

*$p < .05$

**$p < .01$

Note: 1 (Activity Level), 2 (Anger), 3 (Discomfort), 4 (Reactivity), 5 (Fear), 6 (High Intensity), 7 (Impulsivity), 8 (Sadness), 9 (Shyness), 10 (Negative Affect), 11 (Effortful Control), 12 (Energy Level), 13 (Depressed/Anxious), 14 (Reticence), 15 (SQRT of Total of Home Daycare, 16 (LN of CBCL Internalizing), 17 (SQRT of CBCL Externalizing), 18 (Parental Sensitivity group)

Table 7

Regression Model Predicting Internalizing Problems – Hypothesis 1

Variable	B	SE B	β	*p*	ΔR^2	ΔF	*p*
Step 1					.06	1.78	.18
Shyness	.13	.07	.24	.072			
Months of Out-of-home care	-.03	.05	-.09	.510			
Step 2					.03	1.86	.18
Shyness	.10	.07	.20	.15			
Months of Out-of-home care	-.01	.05	-.03	.82			
Shyness x Months of Out-of-home care	.06	.04	.19	.18			

Table 8

Regression Model Predicting Externalizing Problems – Hypothesis 1

Variable	B	SE B	β	*p*	ΔR^2	ΔF	*p*
Step 1					.06	1.88	.16
Energy level	.14	.07	.25	.057			
Months of Out-of-home care	.00	.08	.00	1.0			
Step 2					**.07**	**4.43**	**.04**
Energy level	.11	.07	.20	.12			
Months of out-of-home care	.01	.08	.01	.95			
Energy level x Months of Out-of-home care	**-.07**	**.03**	**-.27**	**.04**			

Energy level: CBQ Activity, High Intensity, and Impulsivity

Table 9

Regression Model Predicting Internalizing Problems – Hypothesis 1 Post-hoc

Variable	B	SE B	β	*p*	ΔR^2	ΔF	*p*
Step 1					**.14**	**2.92**	**.042**
Depressed/anxious	**.09**	**.03**	**.35**	**.012**			
Reticence	.02	.04	.05	.702			
Months of Out-of-home care	-.04	.05	-.10	.430			
Step 2 (1st interaction)					.01	.40	.530
Depressed/anxious	**.08**	**.03**	**.34**	**.016**			
Reticence	.01	.05	.04	.759			
Months of Out-of-home care	-.03	.05	-.08	.560			
Depressed/anxious x Months of Out-of-home care	.01	.02	.09	.530			
Step 2 (2nd interaction)					.06	3.6	.063
Depressed/anxious	**.08**	**.03**	**.32**	**.020**			
Reticence	.01	.04	.03	.847			
Months of Out-of-home care	-.02	.05	-.06	.662			
Reticence x Months of Out-of-home care	.04	.02	.24	.063			

Depressed/anxious: CBQ Sadness, Discomfort, Reactivity (reversed), and Fear
Reticence: CBQ Shyness and Impulsivity (reversed)

Table 10

Regression Model Predicting Internalizing Problems – Hypothesis 1 Post-hoc

Variable	B	SE B	β	*p*	ΔR^2	ΔF	*p*
Step 1					**.16**	**3.5**	**.021**
Negative Affect	**.08**	**.03**	**.40**	**.002**			
Effortful Control	.01	.01	.10	.450			
Months of out-of-home care	-.04	.05	-.10	.421			
Step 2 (1st interaction)					.00	.04	.836
Negative Affect	**.08**	**.03**	**.40**	**.003**			
Effortful Control	.01	.01	.09	.488			
Months of Out-of-home care	-.04	.05	-.10	.453			
Negative Affect x Months of Out-of-home care	.00	.01	.03	.836			
Step 2 (2nd interaction)					.04	2.5	.120
Negative Affect	**.08**	**.03**	**.37**	**.005**			
Effortful Control	.01	.01	.13	.324			
Months of Out-of-home care	-.03	.05	-.08	.504			
Effortful Control x Months of Out-of-home care	.01	.00	.20	.120			

Negative Affect: CBQ Sadness, Fear, Anger/Frustration, Discomfort, and Soothability (reversed)
Effortful Control: CBQ Inhibitory Control, Attention, Low Intensity, Perceptual Sensitivity

Table 11

Regression Model Predicting Externalizing Problems – Hypothesis 1 Post-hoc

Variable	B	SE B	β	*p*	ΔR^2	ΔF	*p*
Step 1					.02	.36	.784
Negative Affect	.04	.05	.13	.344			
Effortful Control	-.00	.01	-.04	.779			
Months of out-of-home care	-.01	.09	-.02	.895			
Step 2 (1st interaction)					.00	.22	.638
Negative Affect	.04	.05	.12	.388			
Effortful Control	-.01	.01	-.05	.714			
Months of Out-of-home care	-.00	.09	-.01	.961			
Negative Affect x Months of Out-of-home care	.01	.02	.07	.638			
Step 2 (2nd interaction)					.06	3.61	.063
Negative Affect	.03	.05	.09	.517			
Effortful Control	.00	.01	-.00	.996			
Months of Out-of-home care	.00	.08	.01	.969			
Effortful Control x Months of Out-of-home care	.01	.01	.26	.063			

Negative Affect: CBQ Sadness, Fear, Anger/Frustration, Discomfort, and Soothability (reversed)
Effortful Control: CBQ Inhibitory Control, Attention, Low Intensity, Perceptual Sensitivity

Table 12

Regression Model Predicting Parental Sensitivity – Hypothesis 2

Variable	B	SE B	β	*p*	ΔR^2	ΔF	*p*
Step 1					.09	1.73	.171
Shyness	-.20	.13	-.21	.147			
Energy level	.09	.09	.15	.310			
Months of out-of-home care	.04	.09	.05	.687			
Step 2 (1st interaction)					**.07**	**4.44**	**.040**
Shyness	-.11	.14	-.12	.402			
Energy level	.11	.08	.19	.181			
Months of Out-of-home care	-.03	.10	-.04	.749			
Shyness x Months of Out-of-home care	**-.15**	**.07**	**-.30**	**.040**			
Step 2 (2nd interaction)					.04	2.57	.115
Shyness	-.19	.13	-.21	.157			
Energy level	.11	.09	.18	.209			
Months of Out-of-home care	.04	.09	.05	.691			
Energy level x Months of Out-of-home care	.06	.04	.21	.115			

Energy level: CBQ Activity, High Intensity, and Impulsivity

Table 13

Regression Model Predicting Parental Sensitivity – Hypothesis 2 Post-hoc

Variable	B	SE B	β	*p*	ΔR^2	ΔF	*p*
Step 1					.09	1.74	.170
Depressed/anxious	-.01	.07	-.02	.869			
Reticence	**-.17**	**.08**	**-.30**	**.042**			
Months of out-of-home care	.04	.09	.05	.688			
Step 2 (1st interaction)					**.13**	**8.42**	**.005**
Depressed/anxious	-.05	.06	-.12	.401			
Reticence	**-.20**	**.08**	**-.34**	**.013**			
Months of Out-of-home care	.08	.09	.11	.380			
Depressed/anxious x Months of Out-of-home care	**.09**	**.03**	**.38**	**.005**			
Step 2 (2nd interaction)					**.08**	**4.90**	**.031**
Depressed/anxious	.01	.06	.02	.870			
Reticence	-.15	.08	-.25	.070			
Months of Out-of-home care	-.00	.09	-.01	.972			
Reticence x Months of Out-of-home care	**-.09**	**.04**	**-.30**	**.031**			

Depressed/anxious: CBQ Sadness, Discomfort, Reactivity (reversed), and Fear
Reticence: CBQ Shyness and Impulsivity (reversed)

Table 14

Regression Model Predicting Parental Sensitivity – Hypothesis 2 Post--hoc

Variable	B	SE B	β	*p*	ΔR^2	ΔF	*p*
Step 1					.04	.70	.559
Negative Affect	-.06	.05	-.16	.238			
Effortful Control	.01	.01	.10	.442			
Months of out-of-home care	.02	.10	.03	.822			
Step 2 (1st interaction)					**.07**	**4.09**	**.048**
Negative Affect	-.09	.05	-.24	.089			
Effortful Control	.01	.01	.06	.639			
Months of Out-of-home care	.04	.09	.05	.701			
Negative Affect x Months of Out-of-home care	**.06**	**.03**	**.28**	**.048**			
Step 2 (2nd interaction)					.00	.00	.998
Negative Affect	-.06	.05	-.16	.247			
Effortful Control	.01	.01	.11	.448			
Months of Out-of-home care	.02	.10	.03	.828			
Effortful Control x Months of Out-of-home care	.00	.01	.00	.998			

Negative Affect: CBQ Sadness, Fear, Anger/Frustration, Discomfort, and Soothability (reversed)
Effortful Control: CBQ Inhibitory Control, Attention, Low Intensity, Perceptual Sensitivity

Table 15

Bivariate Correlations between Difference in Temperament and Difference in Sensitivity for MZ Twin Pairs – Hypothesis 3

Variables	Sensitivity Difference Score
Energy level difference	.42
Shyness difference	-.36
Depressed/anxious difference	-.33
Reticence difference	-.37
Negative Affect difference	-.36
Effortful Control difference	.73*

*$p < .001$

Table 16

Bivariate Correlations between Difference in Temperament and Total Months of Daycare for All Twin Pairs – Hypothesis 4a

Variables	Total months of daycare (SQRT)
Energy level difference	.04
Shyness difference	.19
Depressed/anxious difference	.20
Reticence difference	.19
Negative Affect difference	.22
Effortful Control difference	.08

Table 17

Bivariate Correlations between Difference in Temperament and Total Months of Daycare Separately for MZ & DZ Twin Pairs – Hypothesis 4b

	Total months of daycare (SQRT)	
Variables	MZ (N=20)	DZ (N=46)
Energy level difference	.10	.01
Shyness difference	.12	.22
Depressed/anxious difference	-.14	.33*
Reticence difference	.10	.22
Negative Affect difference	-.14	.35*
Effortful Control difference	-.16	.15

Note: Both significant DZ correlations are significantly different from corresponding MZ correlations according to Fisher's r→z transformations

*$p < .05$

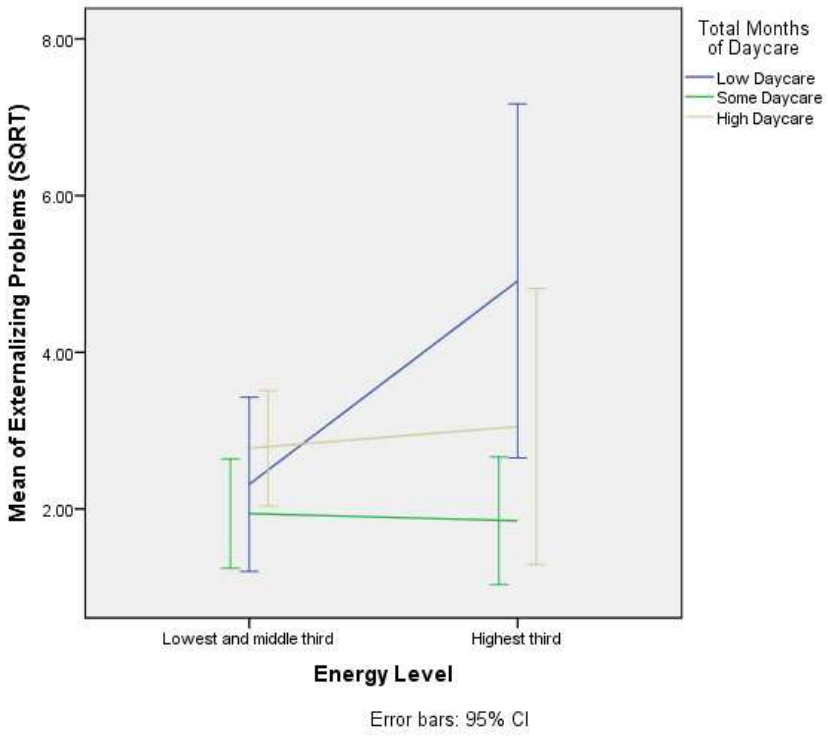

Figure 1. Interaction between total months of daycare and energy level as they predict externalizing behavior.

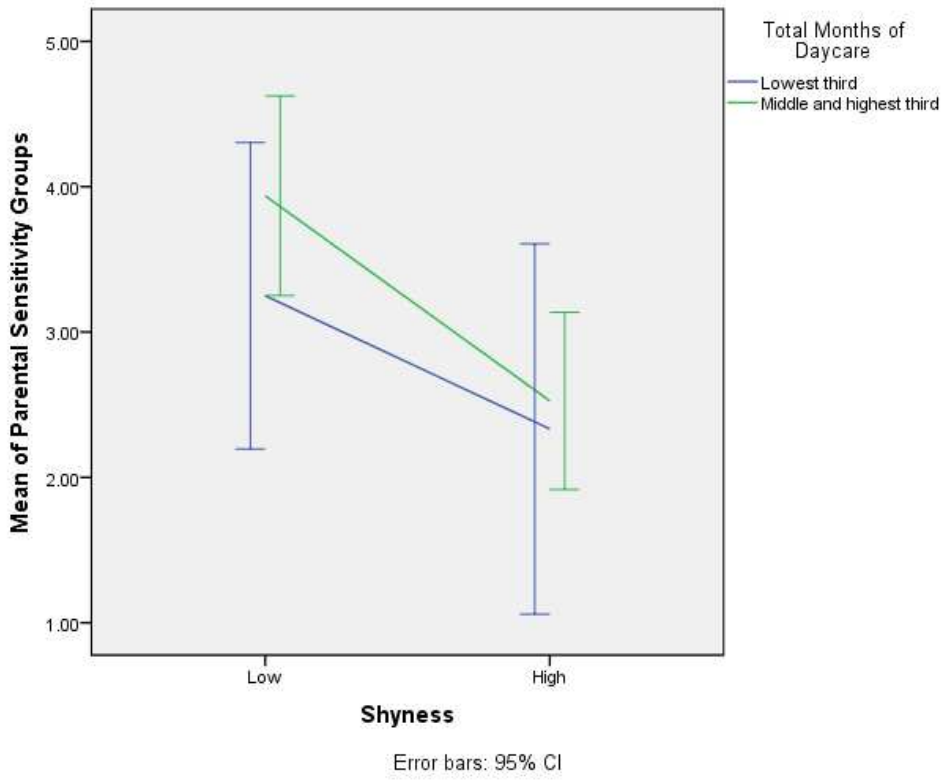

Figure 2. Interaction between total months of daycare and shyness as they predict parental sensitivity.

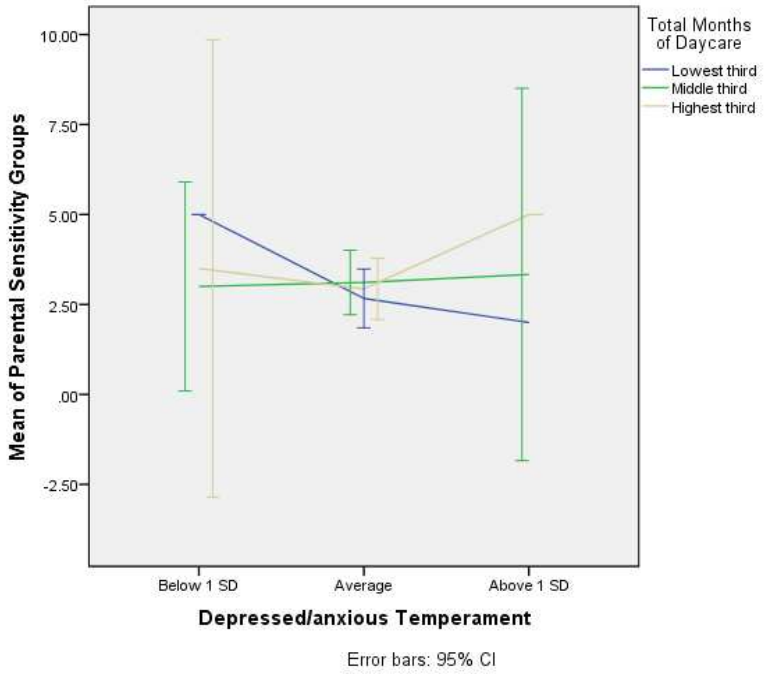

Figure 3. Interaction between total months of daycare and depressed/anxious temperament as they predict parental sensitivity.

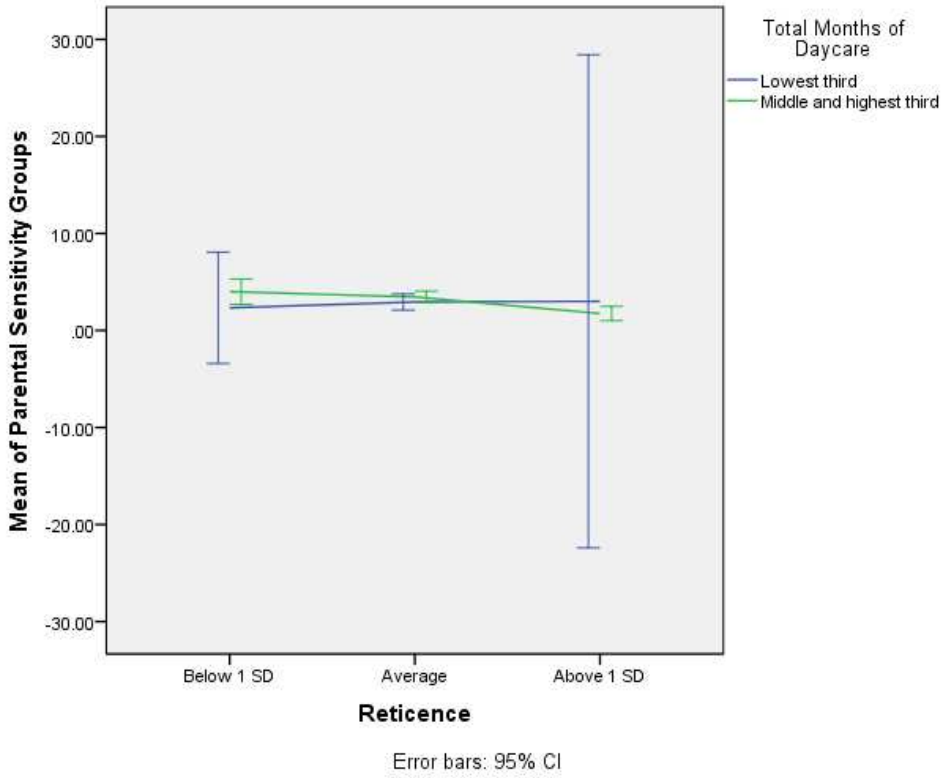

Figure 4. Interaction between total months of daycare and reticence as they predict parental sensitivity.

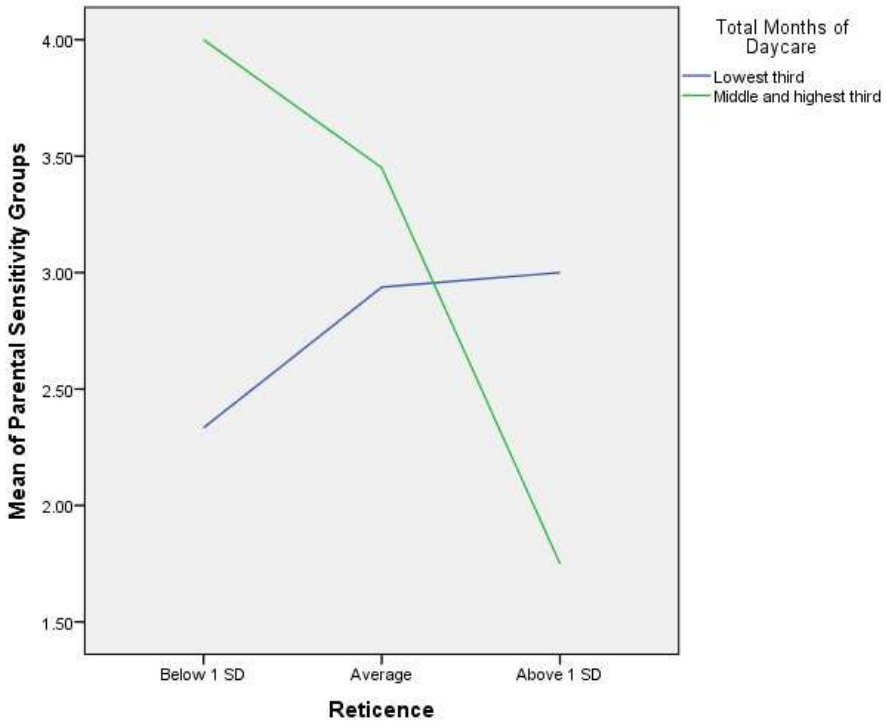

Figure 4a. Interaction between total months of daycare and reticence as they predict parental sensitivity (without error bars).

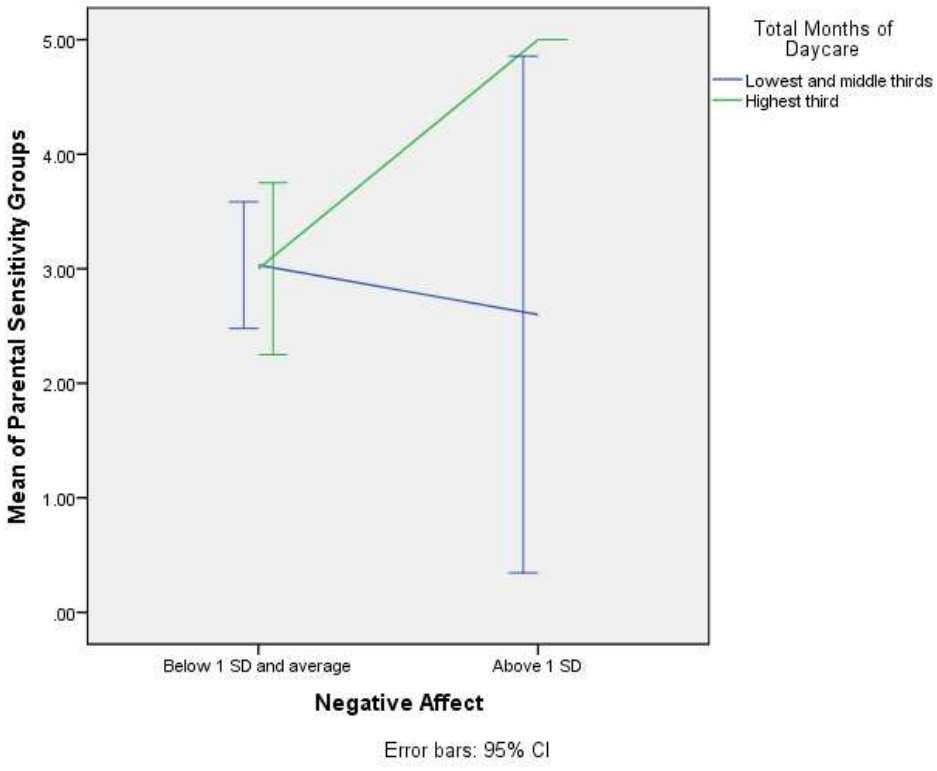

Figure 5. Interaction between total months of daycare and negative affect as they predict parental sensitivity.

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APENDICES

Appendix A

INFORMATION SHEET

Date_____ ID Number_____

Age of Child/ren _____ DOB of child/ren_____

Your Relationship to the child/ren (mother or father; please note if adoptive parent):_____

Your Age: _____

Marital Status:

Single, never married_____ Married_____ Divorced/Separated _____ Widowed _____

Living with a significant other_____

Approximate Total Family Income:

_____ less than $5,000 _____ $20,000 to 25,000 _____ $40,000 to 45,000

_____ $5,000 to 10,000 _____ $25, 000 to 30,000 _____ $45,000 to 50,000

_____ $10,000 to 15, 000 _____ $30,000 to 35,000 _____ $50,000 to 55,000

_____ $15,000 to 20,000 _____ $35,000 to 40,000 _____ over $55,000

Race of Child's Parents: Mother _____ Father _____

Race of Child/ren in Study: _____

	Occupation (Job Title)	Finished High School?	Attended College?	Years of College (undergraduate & graduate)	College Degrees (AA, BA, etc.)
Self		Yes No if yes, please continue>	Yes No if yes, please continue>		

Spouse or Significant Other if Living in Home with Child/ren		Yes No if yes, please continue>	Yes No if yes, please continue>		

Siblings of Child/ren in the Study

Please start the list with the **OLDEST** sibling and move to the **YOUNGEST**.

(Please do not include the child/ren in the study)

	First sibling	Second sibling	Third sibling	Fourth sibling	Fifth sibling
Birth date					
Circle any that May apply	Half-sibling Step-sibling Adopted	Half-sibling Step-sibling Adopted	Half-sibling Step-sibling Adopted	Half-sibling Step-sibling Adopted	Half-sibling Step-sibling Adopted

Please list everyone living in your household and their relation (e.g., father, grandmother, etc.) to the child/ren in the study. (First names only, example: Ben – grandfather)

_____

_____

We are interested in whether changes in the family, such as divorce or remarriage, affect your child/ren's behaviors. Therefore, the following item will help us to understand when these things may have happened in your family and how they may influence your child/ren.

If applicable, please indicate if you have ever been divorced or remarried and the year this occurred.

Not applicable_____ Divorced _____ Remarried _____

Year_____ Year_____

Year_____ Year_____

ZYGOSITY ASSESSMENT FORM (PARENT)

IDENTICAL OR FRATERNAL?

Please circle the appropriate response.

Rater: Mother or Father

APPEARANCE	Very Similar				Not at all similar
Facial appearance	1	2	3	4	5
Eye color	1	2	3	4	5
Complexion	1	2	3	4	5
Hair appearance	1	2	3	4	5
Hair color	1	2	3	4	5
Hair texture	1	2	3	4	5
Hair curliness	1	2	3	4	5
Hair pattern	1	2	3	4	5
Amount of hair	1	2	3	4	5

"MISTAKEN IDENTITY"
Do people know which twin is which, when the twins are together and when they are apart?

	Frequently confused				Never confused
Mother: apart	1	2	3	4	5
together	1	2	3	4	5
Father: apart	1	2	3	4	5
together	1	2	3	4	5
Friends & relatives:					
apart	1	2	3	4	5
together	1	2	3	4	5

MEDICAL

Has your obstetrician or pediatrician indicated an opinion on whether the twins are identical or fraternal? _____

If so, what is the diagnosis and what is it based on? _____

_____

_____

Is there a history of twinning in your family? If so, please describe.

_____

_____

DAYCARE HISTORY QUESTIONNAIRE

Childcare History

Date _____

ID Number _____

At what age did your child first begin childcare? _____
(Please specify "never" if your child has never been in daycare)

Please fill in the chart below regarding your child's care and school history:

Type of care	Attended this type of daycare?	Beginning age?	Ending age?	Average # of hours per week?	Average # of hours per month?	Circle if care was full or part time.	Care quality (see scale below)
Weekday babysitter at your home	Yes No If yes continue>					Full Part	
Private home (not your own)	Yes No If yes continue>					Full Part	
Informal church daycare	Yes No If yes continue>					Full Part	
Prekindergarten	Yes No If yes continue>					Full Part	
Licensed daycare	Yes No If yes continue>					Full Part	
Regular School	Yes No If yes continue>					Full Part	
Other (Specify)	Yes No If yes continue>					Full Part	

Care Quality Scale

Excellent	Good	Okay	I had serious concerns	Poor
1	2	3	4	5

ZYGOSITY ASSESSMENT FORM (RATER)

Twin 1 ID_____
Twin 2 ID_____
Age _____

Zygosity Form
Rater

Family # _____ Sex _____ Test date/time _____

Rater _____

Tester diagnosis: 1 MZ 2 DZ

Rater confusion: 1 None/rare 2 Yes/lots 3 Some/at first

	Very Similar				Not at all similar
Facial appearance	1	2	3	4	5
Eye color	1	2	3	4	5
Complexion	1	2	3	4	5
Hair appearance	1	2	3	4	5
Hair color	1	2	3	4	5
Hair texture	1	2	3	4	5
Hair curliness	1	2	3	4	5
Hair pattern	1	2	3	4	5
Amount of hair	1	2	3	4	5
Ear appearance	1	2	3	4	5

	ID # _____				ID # _____			
Hair color:	Blonde	Red	Brown	Black	Blonde	Red	Brown	Black
Hair darkness:	Light	Medium	Dark		Light	Medium	Dark	
Hair texture:	Coarse	Medium	Fine		Coarse	Medium	Fine	
Amt of Hair:	Lots	Some	Little		Lots	Some	Little	
Hair type:	Curly	Wavy	Straight		Curly	Wavy	Straight	
Eye color:	Blue	Hazel	Brown	Green	Blue	Hazel	Brown	Green

VITA

Graduate School
Southern Illinois University

Kyle A. Bersted

Kylebersted@gmail.com

Creighton University
Bachelor of Arts, Psychology, December 2010

Special Honors and Awards:

Doctoral Graduate Fellowship, Southern Illinois University Graduate School
Master's Graduate Fellowship, Southern Illinois University Graduate School

Thesis Title:

The Impact of Daycare and Child Temperament on Parent-Child Interactions

Major Professor: Lisabeth F. DiLalla

Publications:

DiLalla, L.F., Gheyara, S., and Bersted, K. The Southern Illinois Twins and Siblings Study (SITSS): Description and Update. *Twin Research and Human Genetics*, Available on CJO. doi:10.1017/thg.2012.69